



## **Possibilities for sustainable increase of Danish produced woody biomass 2010-2100**

Graudal, Lars; Nielsen, Ulrik Braüner; Schou, Erik; Thorsen, Bo Jellesmark; Hansen, Jon Kehlet; Bentsen, Niclas Scott; Johannsen, Vivian Kvist

*Published in:*

Conference Proceedings Nordic Workshop "The forest sector in the bio-based economy – perspectives from policy and economic sciences"

*Publication date:*

2014

*Citation for published version (APA):*

Graudal, L., Nielsen, U. B., Schou, E., Thorsen, B. J., Hansen, J. K., Bentsen, N. S., & Johannsen, V. K. (2014). Possibilities for sustainable increase of Danish produced woody biomass 2010-2100. In A. Roos, D. Kleinschmit, A. Toppinen, S. Baardsen, B. H. Lindstad, & B. J. Thorsen (Eds.), *Conference Proceedings Nordic Workshop "The forest sector in the bio-based economy – perspectives from policy and economic sciences" : August 28-29, 2013, Uppsala/Sweden* (pp. 5-10). Sveriges Lantbruksuniversitet (SLU). SLU Forest Products - Proceedings Vol. 2014:1

# **NORDIC WORKSHOP: “THE FOREST SECTOR IN THE BIOBASED ECONOMY – PERSPECTIVES FROM POLICY AND ECONOMIC SCIENCES”**

August 28-29, 2013, Uppsala/Sweden

## **CONFERENCE PROCEEDINGS**



SLU, Forest Products - Proceedings 2014:1



Sveriges lantbruksuniversitet  
Swedish University of Agricultural Sciences

Department of Forest Products

# **NORDIC WORKSHOP: “THE FOREST SECTOR IN THE BIOBASED ECONOMY – PERSPECTIVES FROM POLICY AND ECONOMIC SCIENCES”**

August 28-29, 2013, Uppsala/Sweden

## **CONFERENCE PROCEEDINGS**

- Editors:** Anders Roos, Daniela Kleinschmit,  
Anne Toppinen; Sjur Baardsen,  
Berit Hauger Lindstad, Bo Jellesmark Thorsen
- Organisers:** Scandinavian Society of Forest Economics, Nordic  
Forest Research Co-operation Committee, Swedish  
University of Agricultural Sciences, University of  
Helsinki, Norwegian University of Life Sciences,  
University of Copenhagen, IUFRO
- Series:** SLU Forest Products - Proceedings 2014:1
- ISBN:** 978-91-981682-0-4 (print), 978-91-981683-0-3 (pdf)
- Keywords:** Biobased economy, bioeconomy, sustainability, sustainable  
forest sector
- Electronic publishing:** <http://epsilon.slu.se>

This publication can be downloaded at: [www.sprod.slu.se](http://www.sprod.slu.se), and <http://www.metla.fi/org/ssfe/>

# TABLE OF CONTENTS

<b>TABLE OF CONTENTS</b> .....	<b>1</b>
<b>CONFERENCE INTRODUCTION</b> .....	<b>2</b>
<b>The workshop</b> .....	<b>2</b>
<b>Scientific Committee</b> .....	<b>2</b>
<b>PROGRAM</b> .....	<b>3</b>
<b>EXTENDED ABSTRACTS</b> .....	<b>4</b>
<b>Shades of green: a social scientific view on bioeconomy in the forest sector</b> .....	<b>4</b>
<i>Daniela Kleinschmit, Berit Hauger Lindstad, Bo Jellesmark-Thorsen, Anne Toppinen, Anders Roos and Sjur Baardsen</i>	
<b>Possibilities for sustainable increase of Danish produced woody biomass 2010-2100</b> .....	<b>5</b>
<i>Lars Graudal, Ulrik Braüner Nielsen, Erik Schou, Bo Jellesmark Thorsen, Jon Kehlet Hansen, Niclas Scott Bentzen, and Vivian Kvist Johannsen</i>	
<b>The role of industrial timber construction in a bio-based economy - Mitigating climate and employment effects</b> .....	<b>11</b>
<i>Staffan Brege, Tomas Nord, Daniel Nordigården</i>	
<b>Innovation diffusion of new wood-based materials – shortening ‘time to market’ ...</b>	<b>14</b>
<i>M. Lindström, L. Heuts, N. Hylander, E. Lind, C. Nielsen, A. Roos</i>	
<b>Forest products in the emerging bioeconomy: the role of consumers as a driving force?</b> .....	<b>17</b>
<i>Holopainen, J., Häyrynen, L., Toppinen, A.</i>	
<b>Critical aspects in Corporate Social Responsibility (CSR) reporting in the crossroads of bioenergy and timber production</b> .....	<b>20</b>
<i>Katja Lähtinen, Matti Toivio, Susanna Sironen &amp; Minli Wan</i>	
<b>Competitiveness of wood as a construction material – new possibilities for bioeconomy?</b> .....	<b>22</b>
<i>Maria Riala</i>	
<b>Green Economy: Expectations, Conflicts and Positions</b> .....	<b>26</b>
<i>Holger Bär, Klaus Jacob and Stefan Werland</i>	
<b>Bio-economy – an emerging meta-discourse affecting forest discourses?</b> .....	<b>27</b>
<i>Helga Pülzl, Daniela Kleinschmit, Bas Arts</i>	
<b>Adjusting policy instruments to bio-based forest sector: a Delphi survey to assess stakeholders’ standpoints</b> .....	<b>29</b>
<i>Teppo Hujala, Pasi Rikkinen, Asta Ervola and Jussi Uusivuori.</i>	
<b>Industrial forest plantations for pulp and energy in South America – opportunities and challenges</b> .....	<b>34</b>
<i>Jan-Erik Nylund and Juan Gowda</i>	
<b>Why meagre results despite good conditions and large activity? A case study on the renewal process of the Finnish forest sector 2005-13</b> .....	<b>36</b>
<i>Jakob Donner-Amnell</i>	
<b>Smart Green Growth for Mankind - The Contribution of Forestry to Bioeconomy</b> ....	<b>39</b>
<i>Markku Ollikainen</i>	
<b>Studying the Future of the Forest-Based Sector: Structural Changes towards Bioeconomy</b> .....	<b>40</b>
<i>Hurmekoski, Elias, Hetemäki, Lauri</i>	
<b>Investing in energy forestry under uncertainty</b> .....	<b>45</b>
<i>L. di Corato, A. Gazheli, and C-J Lagerkvist</i>	
<b>Footnotes</b> .....	<b>47</b>

# CONFERENCE INTRODUCTION

The idea of a biobased economy is receiving increasing interest as a way towards a more resource efficient and greener growth. The forest sector (including forestry, industry to forest product market) plays a crucial role for the realization of a biobased economy, particularly in the Nordic countries because these are committed to promote a green growth, have important forest sectors, and implement programs for a bioenergy development.

A biobased economy could foster economic growth with less environmental side effects through innovative and efficient use of forest resources. Key features of a biobased economy include green business development, research, and appropriate economic incentives and policies.

The transition towards a biobased economy involves economic and policy challenges for the forest sector: in designing appropriate regulations and incentives, and stimulating innovation and development, green forest business development. This warrants a better understanding of how policies and markets shape the conditions for the biobased economy in the forest sector. The economic and political sciences can provide insights on these issues, and consequently contribute to the adaptation of the forest sector to a biobased economy. This Nordic workshop is one way to stimulate the dialogue on the topic. It also spot the ‘traps’, and enabling conditions, that can affect this transition.

## The workshop

The workshop aims at identifying the state of the art and future needs regarding the Nordic forest sector within the biobased economy - from a political science/economics/business administration perspective. This includes the following objectives:

Examine how the biobased economy concept could be defined and how it applies to the forest sector.

Identify important actors and drivers for improving the forest sector’s role and contribution are in a bio-based economy.

## Scientific Committee

Daniela Kleinschmit, and Anders Roos (SLU, Sweden); Anne Toppinen (University of Helsinki, Finland); Sjur Baardsen, Berit Hauger Lindstad (Norwegian University of Life Sciences); Bo Jellesmark Thorsen (University of Copenhagen, Denmark)

# PROGRAM

<b>28 August</b>	
<b>12.45-14.15</b> <b>Moderator:</b> <b>Anne Toppinen</b>	Overview studies on Bioeconomy 1) <b>Kleinschmit D</b> , Lindstad B, Toppinen A, Jellesmark Thorsen B, Baardsen S, Roos A: Conceptualizing socio-economic research of the bio-economy 2) <b>Graudal L</b> , Bräuner Nielsen U, Schou E, Jellesmark Thorsen B, Kehlet Hansen J, Scott Bentzen N, Kvist Johannsen V: Possibilities for sustainable increase of Danish produced woody biomass 2010-2100. 3) <b>3. Brege S, Nord T, Nordigården D</b> : The role of industrial timber construction in a bio- based economy - Mitigating climate and employment effects
<b>14.15-15.00</b>	Biobased economy – the Business Case 4) <b>Lindtröm M</b> , Heuts, Hylander, Lind, Nielsen, Roos: Innovation diffusion of new wood based materials – shortening time to market
<b>15.30-17.00</b> <b>Moderator:</b> <b>Anders Roos</b>	The Business Case (contd.) 5) <b>Holopainen J</b> , Häyrynen L., Toppinen A: Forest products in the emerging bioeconomy: the role of consumers as a driving force? 6) <b>Lähtinen K</b> , Toivio M, Sironen S, Wan M: Critical aspects in Corporate Social Responsibility (CSR) reporting in the crossroads of bioenergy and timber production 7) <b>Riala M</b> : Competitiveness of wood as a construction material – new possibilities for bioeconomy?
<b>29 August</b>	
<b>8.15-9.00</b>	Political dimension of Bio-based economy 8) <b>Bär H, Jacob K, Werland S</b> : Expectations, Conflicts and Positions on Strategies for a Green Economy
<b>9.30-11.30</b> <b>Moderators:</b> <b>Daniela Kleinschmit and Berit Lindstad</b>	Political dimension (contd.) 9) <b>Pülzl H</b> , Kleinschmit D, Arts B: Bio-economy – an emerging meta-discourse affecting forest discourses? 10) <b>Hujala T</b> , Rikkinen P, Ervola A, Uusivuori J: Adjusting policy instruments to bio-based forest sector. Designing a delphi survey to assess stakeholders standpoints... 11) <b>Nylund J-E</b> , Gowda J: Industrial forest plantations for pulp and energy in South America – opportunities and challenges 12) <b>Donner-Amnell J</b> : Promising prospects half- hearted action and bleak results
<b>12.30-13.15</b>	Economic perspective on the bio-based economy Keynote: 13) <b>Ollikainen M</b> : Smart Green Growth for Mankind The Contribution of Forestry to Bioeconomy
<b>13.15-14.45</b> <b>Moderators:</b> <b>Sjur Baardsen and Bo Jellesmark Thorsen</b>	Economic perspective (contd.) 14) <b>Hurmekoski E</b> , Hetemäki: Studying the Future of the Forest-Based Sector: Structural Changes towards Bioeconomy 15) <b>Di Corato L</b> , Gazheli A, Lagerkvist C-J: Investing in energy forestry under uncertainty

# EXTENDED ABSTRACTS

## Shades of green: a social scientific view on bioeconomy in the forest sector

*Daniela Kleinschmit<sup>1</sup>, Berit Hauger Lindstad<sup>2</sup>, Bo Jellesmark-Thorsen<sup>3</sup>, Anne Toppinen<sup>4</sup>, Anders Roos<sup>1</sup> and Sjur Baardsen<sup>2</sup>*

<sup>1</sup>Department of Forest Products, Swedish University of Agricultural Sciences, Uppsala, Sweden

<sup>2</sup>Department of Ecology and Natural Resource Management, Norwegian University of Life Sciences, Aas, Norway

<sup>3</sup>Department of Food and Resource Economics, University of Copenhagen, Denmark.

<sup>4</sup>Department of Forest Sciences, University of Helsinki, Finland

Politics increasingly highlight the importance of strengthening a bioeconomy. Major aim of political bioeconomy strategies is the call for a shift towards a society relying strongly on renewable biological sources while achieving economic growth. Knowledge, innovation and sustainable management are identified as core factors contributing to achieve this aim (EU Commission, 2012a). Forests and the forests sector is expected to provide a significant contribution to a bioeconomy (ibid.).

So far the majority of bioeconomy studies are within natural science and engineering perspectives, such as biotechnology or genetic engineering. However, it has been acknowledged that the road toward a bioeconomy involves economic and policy challenges, e.g. in order to implement appropriate regulations, foster information exchange, get incentives right, and support knowledge development (Najam and Selin 2011). Furthermore innovations are needed on greener products and in developing new greener businesses. In accordance with these challenges the OECD states that social analysis is necessary in order to guide policymaking (OECD, 2009). In order to gain a deeper understanding on how policies and market forces interact and shape conditions for the bioeconomy, social scientific research comprising the areas of political and economic sciences needs to be conducted.

The bioeconomy concept has developed to include a great variety of agendas and ambitions implying challenges and opportunities for the forest sector. However, previous reviews done on the evolving bioeconomy (e.g. McCormick and Kautto 2013) have not analyzed it from the perspective of the forest sector. Therefore this conceptual paper aims to (1) present socio-economic theoretical frameworks and research areas relevant for a more holistic understanding of the bioeconomy concept applied to the forest sector, and (2) identify a core set of potential contributions from social sciences for enhancing the bioeconomy in the forest sector.

The paper starts with shedding light on the different perspectives inherent in the bioeconomy concept (section 2). In the third section, the paper presents selected theoretical frameworks and examples of studies within policy, economic and business administration disciplines relevant for understanding bioeconomy in the forest sector. In the fourth section, missing research areas and possible contributions for future socio-economic research are discussed before concluding the paper in section five.

## References

- EU Commission. 2012a. Innovating for Sustainable Growth: A Bioeconomy for Europe. Communication from the Commission to the European Parliament, the Council, the European economic and Social Committee and the Committee of the regions, Brussels 13.2.2013.
- McCormick, K., Kautto, N. 2013. The Bioeconomy in Europe: An Overview. *Sustainability*, 5: 2589-2608.
- Najam, A., Salin, H. 2011. Institutions for a Green Economy. *Review of Policy Research*, Volume 28 (5): 451-457.

# Possibilities for sustainable increase of Danish produced woody biomass 2010-2100

*Lars Graudal<sup>1</sup>, Ulrik Braüner Nielsen<sup>1</sup>, Erik Schou<sup>2</sup>, Bo Jellesmark Thorsen<sup>2</sup>, Jon Kehlet Hansen<sup>1</sup>, Niclas Scott Bentzen<sup>1</sup>, and Vivian Kvist Johannsen<sup>1</sup>*

<sup>1</sup>Department of Geosciences and Natural Resource Management, Faculty of Science, University of Copenhagen, Rolighedsvej 23, 1958 Frederiksberg C, Denmark, lgr@life.ku.dk

<sup>2</sup>Department of Food and Resource Economics, Faculty of Science, University of Copenhagen, Rolighedsvej 23, 1958 Frederiksberg C, Denmark

Extended abstract prepared for the Nordic Workshop: “The forest sector in the biobased economy – perspectives from policy and economic sciences” August 28-29, 2013, Uppsala/Sweden

This abstract is based on a longer study prepared in Danish for the Danish Nature Agency (Ministry of Environment) during 2013 (Graudal *et al.* 2013).

## Purpose of study

The purpose of this study is to assess the possibilities to increase production and optimize the use of the wood resource in the Danish forests over the next 100 years on a sustainable basis and with due consideration to other forest functions.

## Goals for the use of wood in Danish energy supply

The Danish Governments aim for a so-called green conversion of the Danish society implies that Denmark by 2050 should rely only on sustainable energy sources. Biomass is expected to play a significant role in this change to a green economy. Currently wood constitute about half of the biomass used for energy in Denmark and around 10 % of the total energy consumption in Denmark. Approximately 50 % of the wood based energy supply is from imported wood.

## The use of wood and forestry to mitigate climate change

Wood may substitute fossil fuels or more energy demanding materials used for other purposes. Wood products used for other purposes than energy may also store carbon for a considerable period of time. A condition for such a positive effect on the carbon balance is that the wood harvest is sustainable. In simple terms this means that the wood should come from forest where the standing volume of wood and other carbon accumulation in the forest are maintained or increasing.

## Wood consumption in Denmark

The consumption of wood in Denmark is large. Total consumption in 2011 is estimated at 18 million m<sup>3</sup>, of which 8.5 million m<sup>3</sup> was for energy purposes. Import was around 11.5 million m<sup>3</sup>, so self-sufficiency was less than one-third. Of the wood produced in Denmark around 3.5 million m<sup>3</sup> came from the forests. Figures are uncertain because they are composed from different sources.

In a climate and energy context it is the contents of carbon and energy which is of interest. 18 million m<sup>3</sup> of wood corresponds to approximately 9 million tons dry matter, 4.5 million tons of carbon or 16.5 million tons CO<sub>2</sub>. In comparison the Danish emission of CO<sub>2</sub> equivalents in 2011 was 55.8 million tons. The energy content of 18 million m<sup>3</sup> wood is around 162 PJ corresponding to about 20 % of the current Danish energy consumption.

## How can the production of wood and the carbon storage of the forests be increased?

To assess how much the growth of the forests can be increased, point of departure has been taken in the current species and age class composition of the forests (based on the National Forest Inventory (NFI)).

The effect on growth of nine silvicultural measures (parameters) and four different combinations (scenarios) of these parameters have been modelled. The nine parameters and the four scenarios are



shown in table 1. Other scenarios could be analysed as well, using other combinations of the silvicultural measures.

*Table 1. The nine silvicultural measures (parameters) and the four different combinations of these parameters (scenarios) assessed by modelling in the study. BAU is current practice (Business as usual), BIO focuses on biomass production, ENV focus on environmental values and Combi combines production and environmental concerns.*

Silvicultural measures/Parameters	Scenarios			
	BAU	BIO	ENV	Combi
Establishment of new forest: How much forest is planted on former agricultural land per year (ha)	1900	1900	4560	4560
Which tree species are used for these new forests?	As now	More conifers	More broadleaves	As now
What is the expected rotation age of the new forests?	As now	Younger	Older	As now
Which species are used for regeneration of existing forests?	As now	More conifers	More broadleaves	As now
How is the forest regenerated? More intensive regeneration: Higher planting density, use of fast growing cover crops, providing early and higher biomass production	As now	Intensive	As now	Intensive
How large areas are kept out of forest production management to serve e.g. biodiversity (in % of current forest area)	As now	As now	ca. 10 %	ca. 10 %
How many and how much of the individual tree is removed from the forest?	As now	More	Less	As now
What is the wood used for? E.g. firewood or timber. More or less energy wood.	As now	More energy wood	Less energy wood	More energy wood
How good is the planting material in planted forest in terms of breeding intensity	As now	More breeding	More breeding	Intensive breeding

### **How large is the effect on production and the build-up of volume (carbon) in the forest?**

Table 2 show total harvest under the four scenarios (see also figure 1) and how large a share of the home consumption this may cover. BAU remains at a self-sufficiency of around 25 %, whereas this may increase to about 30 % under other scenarios in 2050 and continue to increase up to 40-50 % towards 2100 primarily through a combination of increased forest area (Combi and ENV), more intensive silviculture and breeding (BIO and Combi), higher degree of utilization (BIO), but also combined with concern for biodiversity and environment (ENV and Combi).

Table 3 focuses on the supply of wood for energy under the 2050 goal of achieving 100 % sustainable energy supply. The table show home production in forest, i.e. excl. production outside forest and import. Already BAU shows an increasing coverage due to the expectation of increasing energy efficiency (lower energy consumption), but also the increasing forest area. The other scenarios show that with the right combination of parameters it should be possible to live up to the 2050 goal and reach this with decreasing dependency on import. There is room for either increasing the share of wood for energy supply or use a larger share of wood for other purposes (cf. table 2), depending on the development of other sources of sustainable energy and to which degree the different silvicultural measures can be implemented in practice. It will of course also depend on what the market demands and at which prices.

Table 2. Development in the annual harvest of wood (million tons dry matter) up to 2100 in total and by wood for industry and energy, and self-sufficiency with wood products (% of total consumption) under the four scenarios.

Harvest (million tons dry matter)		2012	2020	2050	2100
<b>Total consumption</b>		<b>9</b>	<b>10</b>	<b>10.5</b>	<b>10.5</b>
<b>BAU</b>	Industrial	1.4	1.3	1.3	1.6
	Energy	1.0	0.9	1.0	1.2
	<b>Total</b>	<b>2.4</b>	<b>2.3</b>	<b>2.3</b>	<b>2.8</b>
<b>% of consumption</b>		<b>26.5</b>	<b>22.6</b>	<b>22.3</b>	<b>26.8</b>
<b>BIO</b>	Industrial	1.0	1.0	1.0	1.5
	Energy	2.3	2.0	2.4	3.6
	<b>Total</b>	<b>3.3</b>	<b>3.0</b>	<b>3.3</b>	<b>5.1</b>
<b>% of consumption</b>		<b>37.1</b>	<b>29.8</b>	<b>31.7</b>	<b>48.6</b>
<b>ENV</b>	Industrial	0.6	0.6	0.8	1.4
	Energy	1.4	1.2	1.6	2.0
	<b>Total</b>	<b>2.0</b>	<b>1.9</b>	<b>2.4</b>	<b>3.4</b>
<b>% of consumption</b>		<b>22.0</b>	<b>18.8</b>	<b>22.5</b>	<b>32.4</b>
<b>Combi</b>	Industrial	0.6	0.6	0.8	1.5
	Energy	1.6	1.5	2.6	4.1
	<b>Total</b>	<b>2.2</b>	<b>2.2</b>	<b>3.4</b>	<b>5.6</b>
<b>% of consumption</b>		<b>24.8</b>	<b>21.5</b>	<b>32.4</b>	<b>53.0</b>

Table 3. Development up to 2100 in annual harvest of wood for energy in Denmark (million tons dry matter and PJ), share of total energy consumption under the 2050 goal and share of the estimated need for wood energy under this goal (cf. "Vores energi")

Harvest (energy wood)		2012	2020	2050	2100
<b>Total energy consumption (PJ)</b>		81	90	100	100
<b>Wood energy target (PJ)</b>		814	750	650	550
<b>BAU</b>	(million tons dry matter)	0.9	1.0	1.2	1.2
	(PJ)	17.0	18.0	21.2	53.1
<b>% of energy</b>		<b>2.3</b>	<b>2.3</b>	<b>2.8</b>	<b>3.9</b>
<b>% of wood energy target</b>		<b>22.6</b>	<b>18.9</b>	<b>18.0</b>	<b>21.2</b>
<b>BIO</b>	(million tons dry matter)	2.0	2.4	3.6	3.7
	(PJ)	35.8	42.7	65.3	165.1
<b>% of energy</b>		<b>5.1</b>	<b>4.8</b>	<b>6.6</b>	<b>11.9</b>
<b>% of wood energy target</b>		<b>51.2</b>	<b>39.7</b>	<b>42.7</b>	<b>65.3</b>
<b>ENV</b>	(million tons dry matter)	1.2	1.6	2.0	3.0
	(PJ)	22.4	28.2	36.4	136.4
<b>% of energy</b>		<b>3.1</b>	<b>3.0</b>	<b>4.3</b>	<b>6.6</b>
<b>% of wood energy target</b>		<b>30.9</b>	<b>24.9</b>	<b>28.2</b>	<b>36.4</b>
<b>Combi</b>	(million tons dry matter)	1.5	2.6	4.1	4.0
	(PJ)	27.1	46.3	73.9	181.6
<b>% of energy</b>		<b>3.6</b>	<b>3.6</b>	<b>7.1</b>	<b>13.4</b>
<b>% of wood energy target</b>		<b>36.2</b>	<b>30.2</b>	<b>46.3</b>	<b>73.9</b>

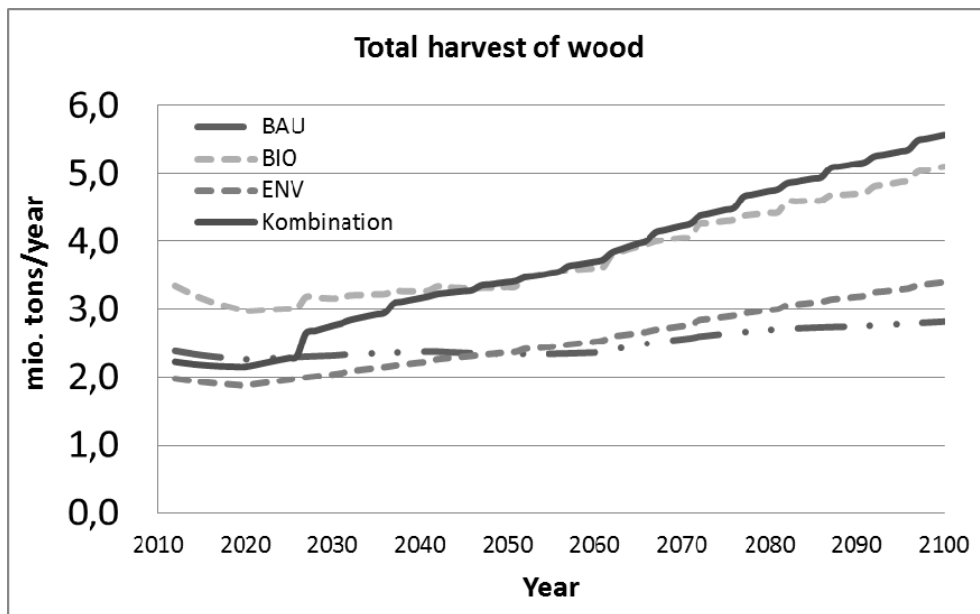


Figure 1. Development of total production for the four scenarios until 2100. Production measured as annual harvest in million ton dry matter of industrial wood and wood for energy.

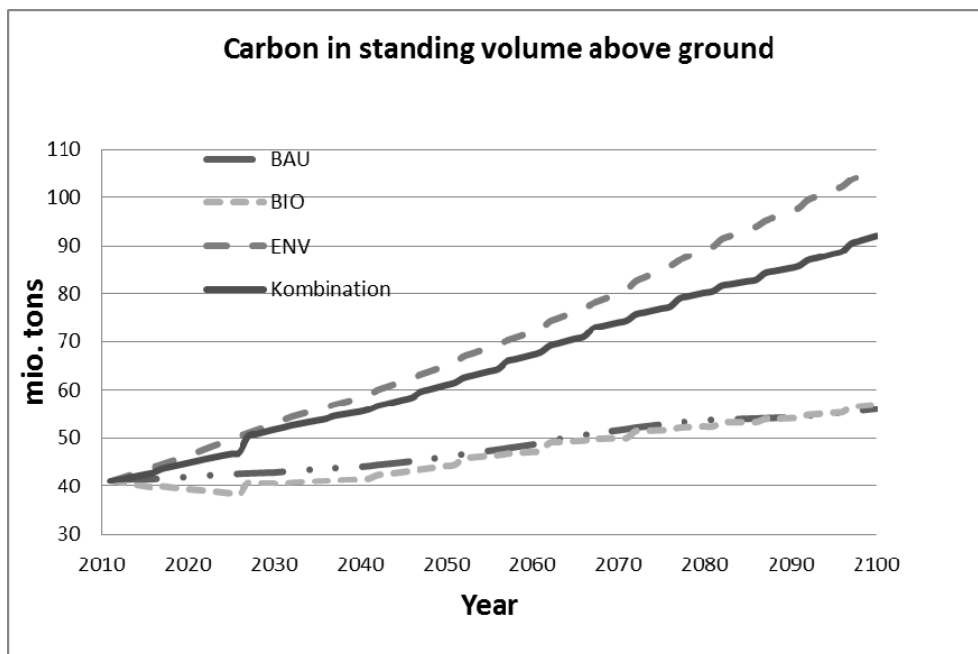


Figure 2. Accumulated amount of carbon in standing volume above ground (million tons.)

## What is the combined effect on the CO<sub>2</sub> balance?

Where *figure 1* and *table 2* and *3* focus on the harvest of products, which have a carbon storage effect in the form of products (part of the industrial wood) and a carbon substitution effect on fossil fuels (the energy wood), *figure 2* shows how much carbon are being built up in the forest itself under the four scenarios, *i.e.* a carbon storage effect in the form of a living storage of which it is possible to calculate the annual growth after harvest.

*Table 4* shows these three effects converted to annual production and growth respectively measured in CO<sub>2</sub> equivalents.

*Table 4. Annual harvest of industrial and energy wood, respectively annual volume increment above and below ground (roots) measured in CO<sub>2</sub> (million tons). Total annual substitution and storage in % of emission of CO<sub>2</sub> in Denmark in 2011 (55.8 million tons)*

	Mio tons	2012	2020	2050	2100
<b>BAU</b>	Industrial	2.5	2.4	2.5	3.0
	Energy	1.9	1.7	1.8	2.2
	Increment above ground	0.3	0.4	0.9	0.7
	Roots	0.1	0.1	0.2	0.1
	<b>Sum</b>	<b>4.8</b>	<b>4.6</b>	<b>5.3</b>	<b>6.0</b>
	<b>% of emission 2011</b>	<b>8.6</b>	<b>8.3</b>	<b>9.6</b>	<b>10.8</b>
<b>BIO</b>	Industrial	1.9	1.8	1.8	2.7
	Energy	4.2	3.6	4.4	6.7
	Increment above ground	-1.2	-0.7	0.9	0.6
	Roots	-0.2	-0.1	0.2	0.1
	<b>Sum</b>	<b>4.7</b>	<b>4.6</b>	<b>7.2</b>	<b>10.1</b>
	<b>% of emission 2011</b>	<b>8.5</b>	<b>8.3</b>	<b>12.9</b>	<b>18.0</b>
<b>ENV</b>	Industrial	1.1	1.2	1.5	2.5
	Energy	2.6	2.3	2.9	3.7
	Increment above ground	2.1	2.2	2.2	2.6
	Roots	0.4	0.4	0.4	0.5
	<b>Sum</b>	<b>6.2</b>	<b>6.0</b>	<b>7.0</b>	<b>9.3</b>
	<b>% of emission 2011</b>	<b>11.1</b>	<b>10.8</b>	<b>12.6</b>	<b>16.7</b>
<b>Combi</b>	Industrial	1.1	1.2	1.5	2.7
	Energy	3.0	2.8	4.7	7.5
	Increment above ground	1.3	1.4	1.8	1.9
	Roots	0.3	0.3	0.4	0.4
	<b>Sum</b>	<b>5.7</b>	<b>5.7</b>	<b>8.4</b>	<b>12.5</b>
	<b>% of emission 2011</b>	<b>10.2</b>	<b>10.2</b>	<b>15.0</b>	<b>22.5</b>

It is seen that the total annual substitution and storage of carbon is very significant and under the scenarios of large forest establishment in 2050 can cover 15 % and in 2100 more than 20 % of the current annual CO<sub>2</sub> emission (2011), which is supposed to decrease in the period entailing that the relative contribution of the forests to mitigate our CO<sub>2</sub> emission will be even larger.

## Discussion and conclusions

The study focus on the effect of different silvicultural measures on wood production and deals only marginally with the welfare economic effects the measures may have on e.g. recreation, groundwater protection, biodiversity, and landscape values. A qualitative assessment of these effects is discussed in the full study, but not included in this abstract. Conclusions given here are therefore limited to the issue of wood production and supply.

It is possible to increase the productivity of the Danish forests considerably and provide a significant contribution to Danish energy targets of achieving a 100 % supply of energy from sustainable sources in 2050 as well as to the reduction of Danish CO<sub>2</sub> emissions. The potential for provision of these services from Danish forests is probably bigger than generally acknowledged given the fact that Denmark is a low forest cover country.

The most important measure to increase production is very straightforward an expansion of the forest area. More surprising is that a combination of other silvicultural interventions - more intensive initial plantings using fast growing species combined with breeding - may contribute to provide a potential increase of productivity of a similar magnitude. Of particular interest is that such high productivity systems can be established without the use of energy demanding fertilizers and pesticides.

The analyses of the study are made at an overall level covering the whole forest area and potential forest area development in Denmark. It is unlikely that such a programme can be implemented at full scale. Implementation will depend e.g. on the size of the estates, their development objectives and access to the relevant silvicultural competence. It is also clear that the potential gains only can be achieved through new investments in research and development of silviculture and tree improvement with focus on adaptation and production.

## References

- Graudal, L., U B Nielsen, E Schou, B Jellesmark Thorsen, J K Hansen, N S Bentzen og V K Johannsen, 2013: Muligheder for bæredygtig udvidelse af dansk produceret vedmasse 2010-2100 [Possibilities for sustainable increase of Danish produced woody biomass 2010-2100]. Perspektiver for skovenes bidrag til grøn omstilling mod en biobaseret økonomi. [Perspectives for the contribution of forests to the green conversion towards a bio-based economy]. Institut for Geovidenskab og Naturforvaltning/Department of Geosciences and Natural Ressource Management, Københavns Universitet/University of Copenhagen, 86 pp ill.

# The role of industrial timber construction in a bio-based economy - Mitigating climate and employment effects

*Staffan Brege<sup>1</sup>, Tomas Nord<sup>2</sup>, Daniel Nordigården<sup>3</sup>*

<sup>1</sup>Staffan Brege - Professor, Department of Management and Engineering, Linköping University; SE-58183 Linköping, Sweden; e-mail: [staffan.brege@liu.se](mailto:staffan.brege@liu.se)

<sup>2</sup>Tomas Nord – Assistant Professor, Department of Management and Engineering, Linköping University; e-mail: [tomas.nord@liu.se](mailto:tomas.nord@liu.se)

<sup>3</sup>Daniel Nordigården - Assistant Professor, Department of Management and Engineering, Linköping University; e-mail: [daniel.nordigarden@liu.se](mailto:daniel.nordigarden@liu.se)

## Introduction

There is an excess usage of fossil fuels in the world today leading to climate consequences that will affect our lives and how we live in the future. Mankind is slowly over-consuming the earth's resources and we are reaching the planetary boundaries with no turning back (Rockström, et al, 2009). Policy-makers and stakeholders are working on establishing visions, strategies and activities addressing these problems and to obtain a consensus of future roadmaps. Among possible developments is the change to a bio-based economy. A bio-based economy aims at utilizing biomass as a renewable material in present and new usages, and to decrease climate affecting resources. It builds on the present bio-based sectors (forestry, agriculture, chemistry and textile) but could be extended to other sectors. Energy is seen as an important and large source of climate affecting substances and there are policies and strategies of how to change from fossil fuel usage to bio-based energy. Examples of policy that address the issue are the EU policy of increasing the usage of bio-based energy in EU to at least 20 % by year 2020. An extensive support system is developed throughout EU and in each country, which has been criticized of not taking a life-cycle perspective and utilizing a “cascading” (Carus, 2012) approach first. A cascading approach in regards to biomass products aims at increasing primary usage first and in a later stage turns the biomass into energy (Carus, et al, 2010). This would also mean effects on the overall economy as there is more employment created in longer value chains.

The purpose of the study is to assess the role of industrial timber construction in a future bio-based economy. The role will be determined in three areas related to the different sustainability perspective (economy, ecology and social), and as follows:

- What possible climatic effect has an increased industrial timber construction (ecological sustainability)?
- What effect has industrial timber construction on employment (economic sustainability)?
- How does an increased industrial timber construction affect future living demands (social sustainability)?

## Material and method

The study has a descriptive approach to assess the present knowledge on the bio-based economy and specifically in regards to the three sustainability pillars. To perform the assessment a single sub-sector of the forest industry, industrial timber construction, was chosen. The choice was based on the product being an end-product, having a clear demand (residential construction), incorporates cascading effects and is new to the sector.

The materials used are research conducted and presented on the effects of industrial timber construction in regards to the three research questions. The literature review was then used as a basis for the assessment of the overall effect in a future bio-based economy.

## Results and discussion

Industrial timber construction is defined in this study as a building project where the building has a timber frame and constructed and assembled under industrial perspective and with a defined organisation and management that focus on optimizing processes, methods and the product instead of

the project (Apelberger et al, 2007; Lessing, 2006; Stehn et al, 2013). Also, industrial construction includes a higher degree of prefabrication than in a traditional building project.

Over the past ten to twenty years there has been extensive research of the industrial timber construction as the ban on the product was lifted in 1994. The research and development has been on the structural side but also economic and ecological progress has been studied. Being a renewable material timber has a low CO<sub>2</sub> footprint compared to the traditional building frame materials concrete and steel (Gustavsson and Sathre, 2006; Brunklaus and Baumann, 2002), and shows the best results in a life-cycle perspective. The literature review regarding the ecological footprint of industrial timber construction indicates an advantage to other materials as it acts as a sink and as a replacement for CO<sub>2</sub> intensive concrete. It is important to include the whole life-cycle and the whole product and not only structural elements. As new construction is becoming more energy efficient the production phase in the construction process is becoming more important and where the choice of material plays a part. At the end of its life cycle the bio-based products are turned into energy.

The future demand on living includes a higher degree of sustainability (SPREAD, 2012). The urbanisation and growth of cities created demands on smaller apartments and real estates, swifter construction and more natural materials for indoor purposes. People are demanding environmentally friendly materials but are more concerned with what they see than what is in the actual structure. It is the function people are after rather than the material i.e. it is industrial rather than timber in industrial timber construction.

The rate of construction in Sweden has been on a low level for at least twenty years with an average annual rate of slight more than 20 000 apartments (SCB, 2012). The construction industry has limited capacity to produce according to the demand without changing methods and has down-sized its organisations. Industrial construction is therefore not a threat to the traditional construction but a necessity to meet the future demands. Timber has an advantage as it is light and strong creating a possibility to have production capacity close to raw material and employment and to deliver products with high prefabrication (Brege et al., 2013). The result is a growing forest industry as larger companies are moving into timber construction. It creates jobs directly at production sites and indirectly at assembly as construction firms are licensed as industrial timber frame assemblers.

A focus on a bio-based economy where a larger share of the renewable biomass products are used in an industrial manner before turned into energy could have an effect on the three sustainability pillars.

- Ecological sustainability: Mitigating an increase in CO<sub>2</sub> in the atmosphere as a sink and as replacement of non-renewable products.
- Economic sustainability: A demand for higher degree of prefabrication in construction opens for industrial timber construction being light and strong and transportable. It creates jobs and builds a new industry based on Sweden's already strong knowledge and competence in industrial production.
- Social sustainability: the least effected by industrialisation as consumer demands are less concerned with framing material than with the function of the building/ apartment.

In a concluding remark the results of the study indicates a need for stakeholders at different levels to act. The forest industry is required to continuously engage further down the value chain and to establish production capacity of timber-based construction products, elements and systems. The research community has a role in the future bio-based economy to act as a facilitator between industry and governmental stakeholders by engaging in development and verification of new products and methods. Finally, stakeholders from the governmental and policy area need to take the leadership in defining the framework and general regulations of a future bio-based economy.

## References

- Apelberger, L, Jonsson, R and Åhman P. 2007. Byggandets industrialisering – Nulägesbeskrivning. FoU Väst rapport 0701. FoU Väst 2007
- Brege, S, Stehn, L. and Nord T. (2013) Business models in industrialized building of multi-storey houses. Construction Management and Economics, On-line Oct. 7<sup>th</sup> 2013.
- Brunklaus, B and Baumann, H. 2002. How would an increased usage of wood mean to the environment? A comparison of LCA studies on frame material (In Swedish). ESA-rapport 2002:06. Institutionen för Miljöanalys, Chalmers.
- Carus, M. 2012. Bio-based economy in the EU-27. A first assessment of biomass use in the EU industry. Nova-institute, Hürth, Germany.
- Carus, M, Piotrowski, S, and Raschka A. (2010) Studie zur Entwicklung von Förderinstrumenten für die Stoffliche Nutzung von Nachwachsenden Rohstoffen in Deutschland. Nova-Institut für politische und ökologische innovation GmbH.
- Gustavsson, L and Sathre R. 2006. Variability in energy and carbon dioxide balances of wood and concrete building materials. Building and Environment, vol. 41, No. 7, pp 940-951.
- Lessing, J. 2008. Industriellt bostadsbyggande. Boverkets Byggbkostnadsforum, Karlskrona 2008
- Rockstrom, J., Steffen, W., Noone, K., Persson, A., Chapin, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sorlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., Foley, J.A., 2009. A safe operating space for humanity. Nature 461, pp. 472-475.
- SPREAD. 2012. Future scenarios for new European social models with visualizations. D4.1. Part of the SPREAD project – Sustainable Lifestyles 2050. Principal authors, Demos Helsinki, Helsinki Finland.
- Stehn, L, Andersson, R. and Engström, D. (2013) Industriella processer för bygg och förvaltning – en forsknings- och innovationsagenda. Insänd till VINNOVA April 2013.



# Innovation diffusion of new wood-based materials – shortening ‘time to market’

*M. Lindström<sup>1</sup>, L. Heuts<sup>2</sup>, N. Hylander<sup>3</sup>, E. Lind<sup>4</sup>, C. Nielsen<sup>5</sup>, A. Roos<sup>6</sup>*

<sup>1</sup> Innventia AB, Stockholm, Sweden. E-mail: mikael.lindstrom@innventia.com

<sup>2</sup> Chalmers University of Technology, Dept of Industriteknik, Sweden. E-mail: lena.heuts@cit.chalmers.se

<sup>3</sup> ÅF Group, Stockholm, Sweden. E-mail: nippe.hylander@afconsult.com

<sup>4</sup> Stora Enso, Stockholm, Sweden. E-mail: erik.lind@storaenso.com

<sup>5</sup> Pöyry Management Consulting, London UK, E-mail: christian.nielsen@poyry.com

<sup>6</sup> Swedish University of Agricultural Sciences, Department of Forest Products. E-mail: anders.roos@slu.se

There is an ongoing discussion about the role of the forest sector for the transition toward a biobased economy. One manifestation of this is in the objectives of the EU, through their technology platform for forest industries and their Strategic Research Agenda for the forest based sector (FTP 2006, 2013) and the corresponding Swedish National Research Agenda (NRA 2006). These documents highlight the need to work for the development of innovative renewable materials in order to be able to replace old finite materials. Forest based, bio-composites, are one example of materials that can boast of environmental advantages concurrent with performance improvements. Hence, innovation of high-performing new forest-based materials can lead to opening of new markets.

It is however difficult to reach success with innovations and often new products fail in the market introduction stage – sometimes despite good functional performance. One reason may be that research is too technical without a good understanding of the innovation diffusion process and the requirements for a successful commercialization. Innovation management also needs to compress the time to market and identify key stakeholders in the innovation process. Nor are specific drivers and barriers for material innovation well known. The purpose of this paper is therefore threefold. First to understand the diffusion process of new wood based materials, “from lab to market”. Second, to identify success factors and barriers for market introduction of forest-based materials. And thirdly, to find important additional complementary capabilities for commercialization success.

The study is based in part on Rogers’ (2003) model on innovation diffusion, in this case of new wood-based materials. We also emphasize the multi-dimensional quality concept including transcendent, product-based, user-based, manufacturing-based, and value-based dimensions (Garvin 1984). To understand the innovation process more we acknowledge that different stages of the process present specific challenges to the innovators (Tidd and Bessant 2009).

The empirics for the study consists of three qualitative interview studies conducted 2010-2012. The first mapped drivers and barriers for biobased material innovations from raw material to the automotive industry. Sub study two investigated what is needed to take a new forest-based material from laboratory to become a successful product on the market, focusing on two different materials: DuraPulp and Nanocellulose. The third sub-study explored the specific innovation process for DuraPulp – its timeline, stages and stakeholders.

The studies showed that the diffusion process of a new material normally takes up to 10 years, and even more. Only a few companies along the supply chains have a specialized function or division with a task of finding new materials. However, the automotive industry regularly monitors the development of new materials. Industrial customers generally obtain information about materials from material suppliers, exhibitions and conferences, professional contacts, industry magazines, digital media, customers, and partners in development.

One critical stage in all materials development is testing. Different industry sectors apply specific material requirements. The automotive industry, for instance, normally apply extensive testing of mechanical properties, climate-resistance and ageing. Regulations on safety issues are key aspects to consider in the development. And interviewees believed that environmental issues and concerns will

increase with time. If the materials are equal in other quality dimensions, environmental performance may cast the deciding vote.

Different professions in the purchasing company - designer, engineer, economists - may apply different priorities in the material selection. Hence, it is important for suppliers of forest-based materials to comply with different requirements. Suppliers must find effective ways to communicate the materials' aesthetic potential to designers, its production possibilities to the engineer, and the economic benefits to the economist. The primary factor for diffusion success of new materials concern basic 'hard' quality requirements such as durability, low weight, functionality and low price. The interview studies furthermore revealed a lack of understanding, and poor communication and contact between various functions in the innovation chain, especially between researchers and manufacturers. Frequent, formal and informal, information exchange between stakeholders and different experts in the diffusion process may at critical points in time, have a decisive role for the innovation and diffusion process.

Motivated and energetic people are crucial for diffusion realization - as is the importance of a good combination of the 'right' competences. Normally, these factors warrant a climate that is conducive to innovation in the organizations and an ability to collaborate across different professional, departmental, and company borders. Financing is of course critical at certain stages and those responsible must be prepared to take calculated risks when new investments for the material are decided.

For most industry sectors successful material development hinges on the ability to present a complete concept that works. Materials must be tested and safety, environmental, and recycling aspects must be considered. This process may take time and which requires both perseverance and long term investments. Perceptions do also play a vital role and prejudice against biomaterials as simple low-quality products may be a disadvantage. A first-mover advantage may be connected to being first out with a new material. However, few developers are willing to pay the additional cost arising from being the first. Technological drawbacks connected to biobased materials refer to difficulties to produce in large scale, and that it is perceived as untested.

Most interviewees agreed that when new materials are meant to improve existing materials, e.g. to use microfibrillated cellulose to make the paper stronger, the forest industry may very well lead the development and marketing process. For 'innovative' products, e.g. DuraPulp, this becomes more difficult and cross-industry collaboration should be considered.

Whereas technical knowledge and research skills were perceived as sufficient, marketing and logistics competence have to be improved. Interviewees believed that forest industries could allocate the material development within independent divisions. Partly because the new production is likely to influence the regular production, and to avoid that large parent conglomerates stifle the promising new production.

Representatives of the automotive sector underscored that selling-in of new material necessitate motivated people with the right personal contacts. Representatives for the packaging industry emphasized that packaging is not an end in itself – it must add value to the content. This calls for collaboration along the value chain, beginning with 'brand owners' specifying how new materials (must) create value for the end product. Such collaboration also entails an understanding for the big picture and what it takes in general to introduce new materials. More interaction along the innovation chain and between different industries foster better market contact, improve a life-cycle perspective. The three sub-studies did not, however, only focus on obstacles. Most industry representatives were interested to enter into collaborations with the forest sector to develop new materials. Forest-based materials may compete where they can conform to existing production structures and compete with incumbent materials in use.

The study's main conclusion is that making contacts, and being open about and sharing information is essential for the success of the innovation process and market launch. Important for the success of an

innovation project is thus ‘gatekeepers’ who like to share their contact network and ensure that the right contacts can be linked together. When contacts have been established, key stakeholders should work together in autonomous project teams to best utilize the diverse skills and experiences.

The investigation also demonstrates that the forest industry need to bring additional skills and / or partners for the success of new materials. Most importantly, market expertise extends to persons or companies with good knowledge about the end-user. This is because the commercialization of new materials will require different skills than those required to sell the standard volume-products (bulk) of the forest industry.

In order for new material to be competitive, they must almost certainly be cheaper than the alternatives. None of the study was interested in paying more for the material just because it was the forest of origin. Should it be possible to charge more for the material, it must provide clear value to the product it is used in. The studies indicate the following recommendations for the development of forest based biomaterials:

- Combine different competences and key actors in the innovation and value chain. Develop cross-industry cooperation with an innovative edge. Involve venture capital and policymakers.
- Develop financing mechanisms.
- Create relevant recycling regulations. Don’t make them too tough. Sometimes it is enough to use the material for energy.
- Be open to new ideas and be generous with your own contacts and information, increased contact may lead to unexpected opportunities.
- Identify individuals who act as gatekeepers and can convey new contacts and share their network.
- Work to involve actors with a different experience, background and skills than in their own organization. This is particularly crucial in the early stages.
- A good form of cooperation may be through autonomous cross-organizational teams of project character. With the right kind of goals can lead to good knowledge sharing and resource-sharing.
- Be careful in identifying your own organization's strengths and core competencies as it can give a big difference in the outcome.
- The role of the organization sponsoring an innovation may be important. The support of an influential person in the organization can create that extra space needed for an idea to develop into an innovation.

**Keywords:** biomaterials, innovation resources, product development, adoption

## References

- FTP 2006. Forest-based sector Technology Platform. A Strategic Research Agenda for Innovation, Competitiveness and Quality of Life. Brussels. 27 p.
- FTP 2013. Renewed FTP-vision. Brussels. 12 p.
- Garvin, D.A. 1984. What Does “Product Quality” Really Mean? Sloan Management Review 26(1), 25–43.
- NRA 2006. National Research Agenda (NRA) – for the Swedish forest-based sector. NRA programme, Brommatryck & Brolins AB. Stockholm.
- Rogers, E. M. 2003. Diffusion of Innovation. Free Press, New York, USA. ISBN: 978-0-7432-2209-9
- Tidd, J., and Bessant, J. 2009. Managing Innovation, Integrating Technological, market and organizational change (4th edition). West Sussex, England: Wiley & sons Ltd.

# Forest products in the emerging bioeconomy: the role of consumers as a driving force?

*Holopainen, J.\* Häyrinen, L., Toppinen, A.*

Department of Forest Sciences, University of Helsinki, Finland.\*email: jani.m.holopainen@helsinki.fi

## Introduction

Progress in sustainable consumption of renewable resource based products and services is one of the key elements in evolving bioeconomy, and mainly related to social aspects of green economy such as quality of life and lifestyle patterns. Consumers, especially the so called LOHAS (lifestyle of health and sustainability, see <http://www.lohas.com/>) segment in the market, are giving increasing consideration to the environmental and social features of products. According to Green and Peloza (2011), corporate sustainability (or corporate responsibility, CR) can provide three forms of value for the consumer: functional, emotional, and social. Commonly mentioned benefits of improved environmental and social performance of product to their suppliers include greater customer loyalty, lower price sensitivity, insurance against negative events, and sometimes even the accrual of positive price premiums. In addition, CR can be also a source of new product, process or business model innovation. In the forestry context, Toppinen et al. (2013) conclude that while CR and forest certification have become accepted means to demonstrate sectoral sustainability, the future challenge is to extend these practices to mainstream markets, to SMEs and to developing countries at costs that would be covered by the often less tangible and longer-term benefits.

Whether consumers in practice are willing to pay (WTP) anything for social and environmental product characteristics has been another matter. For example, according to a large multi-country survey by McKinsey (Bonini and Oppenheim 2008), 87% of consumers surveyed are concerned about the environmental and social impact of the products they buy, 33% say they are willing to pay a premium for green products, and another 54% care about the environment, and want to help tackle climate change. But when it comes to actually making purchasing decisions, words and deeds have been often found to diverge (e.g. Sandhu et al. 2010), and the results on WTP have been sensitive to the preference elicitation method in use. However, there are some potential new triggers, as an interview study by Holopainen et al. (2013) in Finland suggested: with the emergence of EU Timber Regulation on one hand, and on the other the recent adoptions of CoC certification by some large wholesalers/retailers, could act as the pathway to increase the currently low consumer awareness and eventually WTP on the certified wood products.

## Aims and materials of the study

First, we aim to make mainly a conceptual contribution by identifying from the consumer related literature the key contextual determinants for the lack of WTP. Then, we discuss evidence from literature based on the use of different preference elicitation methods, and suggest key attributes towards building a measurement scale for analysing perceived consumer sustainability in a case study of selected wooden furniture product. Next, we test the measurement scale using a small pilot data from 59 forestry students at University of Helsinki, Finland regarding their perceptions on what sustainable wooden furniture products consist of. In conclusions, we will summarize our findings, discuss some first-hand solutions to overcome main barriers of consumption based progress of bioeconomy in the Nordic forest and wood products context and suggest avenues for future research.

## Review of literature and key concepts

The responsible consumer as a driver for bioeconomy is a Janus faced character: consumers are a notoriously heterogeneous and large group in society; they are part of and influenced by complex social networks, and on average lack information and interest to base their buying decisions on sustainability issues. Consequently, a limited smaller segment of frontrunner or LOHAS consumers is likely bearing the main body of risks and costs for pursuing sustainable consumption patterns. Therefore, there are evidently consumer side barriers of sustainability. One of them clearly is associated with (the lack of) consumer WTP, but according to Hopkins (2011), price is not the main

reason. Also the question which particular aspects of product sustainability (on top of forest certification) the Nordic consumer market might be willing to reward has not been properly addressed, and we aim to contribute in this paper on that area.

In existing literature from forest products markets, presence of environmental (forest) certificate has overwhelmingly dominated as an indicator to environmental sustainability, whereas other environmental aspects or those arising from the scope of social sustainability have deserved much less attention. In a recent meta-analysis, Cai and Aquilar (2012) have studied WTP for certified forest products. Based on the study, estimates of consumer's willingness-to-pay premiums for certified wood products ranged from 1.0% to 39.3% over non-certified options. Here, frequently purchased wood products and wood products with lower base prices seemed to capture higher percentage premiums. Interestingly, the meta-analysis did not find any significant correlation between the consumer income-levels and preferences for forest certification.

A recent master's thesis by Heikkonen (2012) found also using meta-regression analysis that consumers in Europe are willing to pay more for eco-labeled wood and paper products than North American consumers. Wooden and durable goods were found to be able to capture larger price premiums compared to less durable wood/paper products, and consumers were willing to pay more for eco-labeled products where the labels provide more information to the consumers. In addition, among demographic variables, age was shown to have a positive influence on the amount that consumers are willing to pay for eco-labeled wood and paper products.

In another recent meta-analysis on 83 studies (of which 20 % focused on forestry related products), Tully and Winer (2013) found a mean WTP premium for socially responsible products to be 17% over normal product and to be lower for durable than for nondurable goods. They also found that on average, 60% of respondents are willing to pay a positive premium and this does not vary by whether the good is durable or not.

About the role of *contextual determinants for the lack of WTP*, a multi-method study by Gleim et al. (2013) examined factors for non-green purchase behavior. They suggest that altering the number and forms of informational product cues may be one solution to overcome purchase barriers of non-green consumers. Methodologically their study also indicated that experimental settings may overcome some inherent weaknesses leading to inflated WTP in qualitative or survey based methods.

Based on review of literature, we were able to identify three dimensions that could be better incorporated in the consumer research on the environmental and social performance of wood products: 1) functional and other product characteristics, 2) presence of forest certification and/or other eco-labels, and 3) sustainable supplier characteristics.

### **Empirical results from testing product level sustainability measurement scale**

Our results from testing measurement scale on sustainability of wooden furniture product used data from 59 students at University of Helsinki participating in two courses, where they were asked to fill in a 5 –point Likert-scale based questionnaire. For the key elements of a measurement scale analysing consumer perceptions on sustainability of a wooden furniture product, we selected 10 product attributes and seven questions on general environmental consciousness and consumer purchase behaviour. No direct measure for WTP was included, as the direct nature of inquiry would have been only likely lead to inflated measures, and based on literature we can also argue that decision on price is either hierarchical or independent with respect to social and environmental sustainability. On average, respondents valued the sustainability criteria high in their purchase decisions and communicated about the product responsibility to others, also in social media.

Preliminary results indicate that dimensionality of sustainability of wooden furniture product can be classified into four dimensions: 1) product level (environmental) performance embedded with functionality of products, 2) aesthetics properties and perceived economic value, 3) certificate reliability and 4) producer image. Thus, in empirical test, theoretically hypothesized first dimension

was found to dissolve into 1) and 2) sub-dimensions above. Due to small sample size and exploratory nature of analysis, results should be treated with caution, but may nevertheless give indication of how to develop a more comprehensive measurement scale for wooden furniture product level sustainability

## Discussion and conclusions

Three dimensional sustainability structure describing the environmental and social performance of wood products was identified from the literature to consist of 1) functional and other core product characteristics, 2) presence of forest certification and/or other eco-labels, and 3) sustainable supplier characteristics. Our pilot data analysis applying the measurement scale to the case of perceived sustainability of wooden furniture product was found to be multidimensional. The preliminary results indicated that the first dimension of functionality embedded also (environmental) responsibility and was distinct from the category of aesthetic properties or “trendiness” of products. The other dimensions from testing the measurement scale were such as reliability of certificate and supplier image were found to be broadly in line with the dimensions found from reviewing the literature. Due to preliminary nature of our empirical analysis, our results are only giving indications on the scope of sustainability in case of wooden furniture products. In future studies, better data set, preferably also using experimental consumer research should be targeted.

In the evolving concept of green or bioeconomy, consumer sector is undoubtedly one important pathway for advancing sustainable development, and also the one that has been a focus of less attention when compared to e.g. creation of coherent cross-sectoral policy frameworks, creating innovation system facilitating technology push by the means of industry initiatives or advancing market supply of renewable raw-materials. In Finnish case, the profile of activities of the Finnish Bioeconomy Cluster (FIBIC, a former Forest Cluster Ltd) is a relatively clear evidence for the difficulty to overcome the dominance of technology push. Market demand, both private and public, is nevertheless an important driver for advancing “green growth”, also as potential source for new product development and co-creation of value in sustainable production-consumption systems.

## References

- Bonini, S. & Oppenheim, J. 2008. Cultivating the green consumer. *Stanford Social Innovation Review*. 6: 56-61.
- Cai, Z. & Aguilar, F.X. 2012 Meta-analysis of consumer’s willingness-to-pay premiums for certified wood products. In press, *Journal of Forest Economics*.
- Gleim, M., Smith, J. Andrews, D. & Cronin, J. 2013. Against the Green: A multi-method examination of the barriers to green consumption. *Journal of Retailing* 89(1), 44-61.
- Green, T. & Peloza, J. 2011. How does corporate social responsibility create value for consumers? *Journal of Consumer Marketing*. 28(1):48-56.
- Heikkonen, H. 2012. Developing Guidelines for an Ideal Eco-label for Wood and Paper Products in the U.S. Master’s thesis, University of Helsinki.
- Holopainen, J., Perttula, S. & Toppinen, A. 2013. Barriers to effectiveness of EUTR in promoting certified wood products market uptake: case Finland. Submitted manuscript.
- Hopkins, M. 2009. What the Green consumer wants? Interview. *MIT Sloan Management Review*. pp. 87-89.
- Sandhu, S., Ozanne, L., Smallman, C. & Cullen, R. 2010. Consumer driven corporate environmentalism: Fact or Fiction? *Business Strategy and the environment*. Vol 19: 356-366.
- Toppinen, A., Cubbage, F. & Moore, S. 2013. Economics of forest certification and CSR. Forthcoming in Kant, S. & Alavapati, J. (eds.) *Handbook of Forest Economics*, Earthscan, London, UK.
- Tully, S. & Winer, R. 2013. Are People Willing to Pay More for Socially Responsible Products: A Meta-Analysis. 38 p. Available at SSRN: <http://ssrn.com/abstract=2240535> or <http://dx.doi.org/10.2139/ssrn.2240535>. <http://www.lohas.com/>

# Critical aspects in Corporate Social Responsibility (CSR) reporting in the crossroads of bioenergy and timber production

*Katja Lhtinen<sup>1</sup>, Matti Toivio<sup>1</sup>, Susanna Sironen<sup>2</sup> & Minli Wan<sup>1</sup>*

<sup>1</sup>University of Helsinki, Department of Forest Sciences

<sup>2</sup>Finnish Environment Institute; Joensuu Research Unit

The role of forests and the challenge of combining international, national and regional level needs related to their sustainable use as a feedstock for bioenergy and social livelihood are major themes in future environmental markets (Dargusch et al. 2010). In current global business environment, forest industries face a challenge to authenticate the acceptability of the usage of wood fiber in industrial processes compared to other uses of forests (Vihervaara & Kamppinen 2011). Corporate Social Responsibility (CSR) reporting provides a micro-level business approach for sustainability assessments grounded on the assumption that environmentally, economically and socially sustainable operations at company-level enhance business development that further contributes to the sustainable development in the globe (Schaltegger et al. 2003).

In global forest industries, the array of options for implementing CSR reporting is vast due to the heterogeneous sustainability requirements in different geographical regions. However, most of companies operating in global arena must focus on some aspects of CSR reporting activities due to, e.g., limited financial resources (Vidal & Kozak 2008). Information is needed on industry-specific critical aspects in forest industries' CSR reporting that could be used for enhancing their strategic planning and contribution to sustainable development (Li et al. 2011). In addition, as forest-based bioenergy production is especially in Nordic circumstances generally inseparable from, for example, timber production, identification of the critical aspects of CSR reporting in forest-based bioenergy production should be made in connection with other optional forms of wood resource usage.

The purpose of the presentation is to introduce a compilation of research projects, where critical aspects in CSR sustainability reporting regarding bioenergy and timber production is assessed with surveys targeted at different stakeholder groups related to non-industrial private forestry (NIPF) and sawmill industry. The classification of critical aspects employed in the surveys is based on the Global Reporting Initiative (GRI), which is one of the most comprehensive guidelines for implementing and developing CSR reporting system both in ecological, economic and social dimensions of sustainability (e.g., Hussey et al. 2001, Morhardt et al. 2002, Lozano & Huisinigh 2010, Li et al. 2011). As a research methodology, multi-criteria decision analysis is employed as a framework for operationalization of survey questionnaires and analysis of results (e.g., Lhtinen et al. 2008).

The results of the research projects provide new information on the critical CSR measures applicable in different decision-making contexts. First, new detailed information on the critical aspects in companies' CSR reporting can be employed in firm-level strategic decision-making to support the acceptability of operations. Second, by enhancing the development of companies' CSR reporting systems, their participation in sustainable development is supported. Finally, new knowledge of the sector-specific characteristics of CSR reporting is acquired.

## References

- Dargusch P., Maraseni T. N. & Schmidt P. 2010. A review of research on forest-related environmental markets (including certification schemes, bioenergy, carbon markets and other ecosystem services). CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources, 5:1–12.
- Hussey, D. M., Kirsop, P. L. & Meissen, R. E. 2001. Global Reporting Initiative Guidelines: An Evaluation of Sustainable Development Metrics for Industry. Environmental Quality Management, 11(1): 1–20.
- Lhtinen, K., Haara, A., Leskinen, P. & Toppinen, A. 2008. Assessing the Relative Importance of Tangible and Intangible Resources: Empirical Results from the Forest Industry. Forest Science 54(6): 607–616.
- Li, N., Toppinen, A., Tuppur, A., Puumalainen, K. & Hujala, M. 2011. Determinants of Sustainability. Disclosure in the Global Forest Industry. Electronic Journal of Business Ethics and Organization Studies, 16(1): 33–40.

- Lozano, R. & Huisinigh, D. 2010. Inter-linking issues and dimensions in sustainability reporting. *Journal of Clean Production* 19(2-3): 99–107.
- Morhardt, J. E., Baird, S. & Freeman, K. 2002. Scoring corporate environmental and sustainability reports using GRI 2000, ISO 14031 and other criteria. *Corporate Social Responsibility and Environmental Management*, 9(4): 215–233.
- Schaltegger, S., Burrit, R. L., & Petersen, H. 2003. *Corporate Environmental Management: Striving for Sustainability*. Sheffield, Greenleaf.
- Vidal, N. G. & Kozak, R. A. 2008. Corporate Responsibility Practices in the Forestry Sector: Definitions and the Role of Context. *The Journal of Corporate Citizenship*, Autumn(2008): 59–75.
- Vihervaara, P. & Kamppinen, M. 2009. The Ecosystem Approach in Corporate Environmental Management – Experts Mental Models and Environmental Drivers in the Finnish Forest Industry. *Corporate Social Responsibility and Environmental Management*, 16: 79–93.



# **Competitiveness of wood as a construction material – new possibilities for bioeconomy?**

*Maria Riala*

Finnish Forest Research Institute, Jokiniemenkuja 1, 01301 Vantaa, Finland, E-mail: maria.riala@metla.fi

## **Introduction**

Buildings account for a large share of greenhouse gas (GHG) emissions. In the EU, buildings account for around 35 % of GHG emissions. (Ruuska & Häkkinen 2012) Construction sector is also a significant actor in the economy. Investments in construction currently account for approximately 13 % of gross domestic product (GDP) in Finland. (Liikanen 2011) Construction sector employs 174,000 people in Finland, not including foreigners. (Rakennusteollisuus 2012)

Introducing environmentally friendly materials and techniques, such as use of wood, to construction could thus reduce the environmental impact of construction sector and convert it into a part of bioeconomy. Bioeconomy can be defined as sustainable use and management of renewable natural resources, production of products and services which use those resources, and use of biological methods in production. (Biotalousyöryhmä 2010)

The environmental impact of substituting wood for other materials has been studied extensively. In a review of literature, Sathre and O'Connor (2010) state that using wood instead of other materials affects GHG emissions by reducing fossil fuel consumption during manufacturing of products; avoiding cement process emissions; storing carbon in the products and in the forest; substituting biomass for fossil fuels; and influencing the carbon dynamics in landfills. While there are uncertainties in the calculations of the reviewed studies, the overall impact of using wood is positive. Each tonne of carbon in wood product reduces emissions by 2.1 tonnes of carbon. Increasing the use of wood in construction does, however, only have a limited impact on total GHG emissions. Ruuska and Häkkinen (2012) estimate that even large increases in use of wood would only reduce total GHG emissions in Finland by 0.2-0.5 %. Increasing the use of wood in construction could also have other beneficial effects. Wood might have other positive environmental impacts, e.g. reducing water pollution and material waste. (CEI-Bois 2006)

Most importantly for bioeconomy and forestry, timber construction offers possibilities for generating new business opportunities. In a situation where the operational environment of forestry is changing (see e.g. Hänninen et al. 2007) it is important to enter new markets. Due to this, wood construction has been promoted heavily in Finland since the 1990s. The strategies have focused on promoting new wooden cities and multi-storey timber construction. A good overview of the projects can be found in Tekes (2011).

Despite significant research and promotional efforts, and 2011 changes in fire regulations, multi-storey timber construction in Finland has increased only slowly. The market share of wood in multi-storey construction is still under 1 %, while in Sweden it has increased to 15 %. (Metsäteollisuus 2013) The share of wood is considerably greater in detached and terraced housing.

The goal of our research was to uncover why multi-storey timber construction has increased so slowly in Finland. In order to analyse this, we asked questions about the competitiveness of wood as a building material, about attitudes towards and experiences of timber construction, about environmental aspects of construction, and about customer orientation in construction. The latter two were included in the study because they are potential sources of competitive advantage. The results are interpreted in the light of possible business opportunities generated.

## **Methods and data**

The data for the study was collected by semistructured interviews. We chose to do interviews because the goal was to get detailed and in-depth information about the experiences of construction sector

actors, not to get more general data from a larger group of respondents. Semistructured interviews produce data, which can be compared among interviewees, while allowing for some flexibility and a conversational tone in the interview situation.

The interviews were conducted in October – December 2012 by Mr Lauri Ilola, a M.Sc. student at the University of Helsinki. He conducted a total of 18 interviews, and contacted around 20 people. The interviews lasted from around 30 minutes to over one hour. All interviews were recorded by the interviewer, and the discussions were typed up afterwards, although not transcribed in full. The interview results will also be used as material for master's thesis of Mr Lauri Ilola, which should be ready in May 2013.

The framework of the study guided the selection of interviewees. The framework was based on the concept of value chains, from wood products to customers of construction companies. We wanted to find out if there is some part of the value chain which acts as a particularly strong opponent of timber construction, which could explain the slow increase of timber construction in Finland. The different stages of value chain could also have different view on the competitiveness of wood.

The interviewees fall into three groups: construction companies (seven interviewees), companies or municipal actors who contract construction companies (seven interviewees, hereafter termed customers), and wood product companies (four interviewees). All the construction companies mainly use concrete in their projects. Three of the customers represented the construction side of large Finnish municipalities, and the rest were companies who rent apartments to people. All the wood product companies have products, which can be used in multi-storey timber construction. The interviewees were overwhelmingly men, as we interviewed only three women. This reflects the male-dominated nature of the Finnish construction sector.

The data was analysed by qualitative means, by utilizing the value chain framework and by searching for themes which emerged from the responses. In analysing the data, the wood product companies are treated as a separate group. Most importantly, they had considerably more limited knowledge of the construction sector. This is highlighted e.g. by the responses to a question on the most important changes, which have taken place in the construction sector since the 1990s. The wood product companies could name hardly any changes, while almost all other interviewees mentioned several changes.

## **Results**

The first interesting finding is that construction sector actors, both construction companies and customers, tended to have very little experience of multi-storey timber construction. Seven of the interviewees had not been involved in any multi-storey timber construction projects, although some had experience of smaller scale timber construction. Four interviewees had experience of a couple of projects, and only three had experience of several projects. Thus, it is useful to treat the level of experience as a background variable when analysing their views on competitiveness.

In terms of cost competitiveness the consensus is that wood has not quite reached the same level as concrete. Many interviewees thought that wood was still more expensive, particularly because wooden structures can require additional soundproofing, which increases the costs. There were no large differences between interviewees with different experience levels, and even the wood product companies did not stand out. Some interviewees thought that the cost competitiveness of wood was already reasonably good, while others thought there was more work to be done. Interestingly, those interviewees who had the most experience of timber construction tended to have the most negative perceptions of cost competitiveness of wood.

The interviewees thought that environmental demands and regulations, e.g. in the form of energy efficiency regulations, would in the future have a greater impact on the construction sector. Unfortunately for wood, the material choice was not seen as a particularly important one in defining green construction. This is probably connected with green building certificates, which give very little

weight for materials. The most important environmental aspects of construction were energy efficiency (provided it did not cause harmful effects on building physics), and location of the buildings. The wood product companies were much more optimistic about meeting the goal for energy efficiency in construction on schedule, which could indicate that they have less comprehensive knowledge of the current situation of the industry.

According to the interviewees, consumers do not care about construction materials. Other aspects of buildings, e.g. location, are much more important to their satisfaction. Some interviewees stated that interior materials can be important, but frame material not. The wood product companies stand out here, as they thought that consumers would want more visible wood in their apartments. They also emphasised the positive feedback received for multi-storey timber buildings to a greater extent than other interviewees. As an interesting contrast, one construction company representative stated that in general people in “special buildings”, such as skyscrapers or timber buildings tend to be more satisfied than others. This was because the residents had self-selected to a type of housing most pleasing to them.

However, wood was perceived to have other benefits, which improve its competitiveness. For instance, it is a light material, and could thus work better on less sturdy ground. The use of factory-made elements could also speed up the process of construction, thus giving faster returns on investment. One interviewee cited this experience from Sweden. The competitiveness of wood could consist of e.g. faster completion times, lighter structures, and working in a weather-shielded environment.

## Conclusions

Although multi-storey timber construction has been promoted enthusiastically in Finland, the market share of wood is still very small. The results of our interview study indicate that this is at least partly due to the insufficient cost competitiveness of wood as a building material. The building sector actors tend to lack experience and skills in timber construction, and as a result are reluctant to take the risk of experimenting with a new material. Nevertheless, they thought that the cost competitiveness of wood had improved, and that changes such as the introduction of standards might help improve the cost competitiveness.

Our results indicate that it will take time and effort for construction sector to form a part of bioeconomy in Finland. While wood has a strong position in smaller scale construction, it only has a small share in multi-storey construction, where much of the business opportunities are. The interviews uncovered some obstacles, such as the cost competitiveness of wood, and lack of skills in timber construction. By addressing these, and creating better timber construction, bioeconomy in Finland could expand to include the construction sector.

**Keywords:** construction, timber, competitiveness, new technology, Finland

## References

- Biotalousuustyöryhmä (2010) Biotalous Suomessa – arvio kansallisen strategian tarpeesta. Final report of bioeconomy working group. Prime minister’s office, publication 15/2010. Available at <http://vnk.fi/julkaisukansio/2010/j15-biotalous/PDF/fi.pdf> accessed 28 March 2013.
- CEI-Bois (2006) Tackle climate change – use wood. Available at <http://www.cei-bois.org/files/b03500-p01-84-ENG.pdf> accessed 27 March 2013.
- Hänninen, R., Toppinen, A., Verkasalo, E., Ollonqvist, P., Rimmmler, T., Enroth, R.-R. and Toivonen, R. (2007) Puutuoteollisuuden tulevaisuus ja puurakentamisen mahdollisuudet. Working paper of the Finnish Forest Research Institute, no 49, available at <http://www.metla.fi/julkaisut/workingpapers/2007/mwp049.pdf> accessed 27 March 2013.
- Liikanen, E. (2011) Asuminen ja rakennusmarkkinat. Presentation on 10 March 2011, available at [http://www.suomenpankki.fi/fi/suomen\\_pankki/ajankohtaista/puheet/Documents/ELpuhe\\_10032011.pdf](http://www.suomenpankki.fi/fi/suomen_pankki/ajankohtaista/puheet/Documents/ELpuhe_10032011.pdf) accessed 28 March 2013.
- Metsäteollisuus (2013) Puutuotteiden läpimurto käynnistymässä kerrostalorakentamisessa. Available at <http://www.metsateollisuus.fi/Infokortit/puukerrostalo/Sivut/default.aspx> accessed 27 March 2013.

- Rakennusteollisuus (2012) Suhdanekatsaus – Rakentaminen loivassa alamäessä. Available for download at <http://www.rakennusteollisuus.fi/RT/Tilastot/RT%3an+suhdannekatsaukset/> accessed 28 March 2013.
- Ruuska, A. and Häkkinen, T. (2012) Potential impact of wood building on GHG emissions. VTT research report.
- Sathre, R. and O'Connor, J. (2010) A synthesis of research on wood products and greenhouse gas impacts. 2<sup>nd</sup> edition. FPInnovations, Technical report no. TR-19R.
- Tekes (2011) Puukerrostalarakentamisen haasteet ja mahdollisuudet. Available at [http://www.tekes.fi/fi/gateway/PTARGS\\_0\\_201\\_368\\_861\\_1845\\_43/http%3b/tekes-ali2%3b7087/publishedcontent/publish/fi\\_content/campaigns/puuska/lisaa/puukerrostalarakentaminen.pdf](http://www.tekes.fi/fi/gateway/PTARGS_0_201_368_861_1845_43/http%3b/tekes-ali2%3b7087/publishedcontent/publish/fi_content/campaigns/puuska/lisaa/puukerrostalarakentaminen.pdf) accessed 27 March 2013.

## **Green Economy: Expectations, Conflicts and Positions**

*Holger Bär, Klaus Jacob and Stefan Werland*

Freie Universität Berlin, Environmental Policy Research Centre, Berlin, Germany. E-mail. [Klaus.jacob@fu-berlin.de](mailto:Klaus.jacob@fu-berlin.de)

The paper summarizes the findings of a discourse analysis of the concept of a Green Economy. The development of a Green Economy was one of the main themes of the Rio +20 summit. The documents prepared by a large variety of actors for the summit were analysed in regards of their narratives. The analysis demonstrates that there is no dominant understanding of the concept of a green economy and identifies the issue areas of conflicts. Controversies can be demonstrated in regards of the relationship between Green Economy and Sustainable Development, the need for a differentiated perspective for developing countries, the need to limit economic growth and new welfare indicators, the sustainability of western consumption culture, and the proposed financing mechanisms. Based on the narratives identified on these issue areas, three discourses are identified: The Greening of the Existing Economies, Green Development, and Sustainable Development with an emphasis on the social development dimension.

**Keywords:** Green Economy, Sustainable Development, Discourse Analysis, Rio +20

# Bio-economy – an emerging meta-discourse affecting forest discourses?

*Helga Püzl<sup>1</sup>, Daniela Kleinschmidt<sup>2</sup>, Bas Arts<sup>3</sup>*

<sup>1</sup>Central-East and South-East European Regional Office of the European Forest Institute & Institute of Forest, Environmental, and Natural Resource Policy at the University of Natural Resources and Life Sciences Vienna (BOKU), Feistmantelstrasse 4, 1180 Vienna, Austria, Email: helga.puezl@efi.int

<sup>2</sup>Department of Forest Products Institute, Swedish University of Agricultural Sciences, PO Box 7008, 75007 Uppsala, Sweden, Email: Daniela.kleinschmidt@slu.se

<sup>3</sup>Forest and Nature Conservation Policy Group, Wageningen University PO Box 47, 6700 AA Wageningen, Netherlands, Email: bas.arts@wur.nl

Bio-economy is a term that is increasingly used in the last years and highlighted for example in the European Union. Only in February 2012 the European Commission has published a new bio-economy strategy entitled “Innovating for Sustainable Growth: a Bioeconomy for Europe”. Following the publication of the strategy a series of bio-economy conferences took place to engage stakeholders, policy-makers and to create partnerships across European regions. In April 2012, the Obama Administration among other countries released its bio-economy strategy “US National Bioeconomy Blueprint”. One year later, in February 2013, the European Commission announced the creation of a new bio-economy observatory that aims at making related data and analyses publicly available, while EU Member States are developing individual bio-economy strategies. Forests are considered part of this European bio-economy strategy. It is intended to improve the related knowledge base and to boost innovation for increasing their productivity and also profitability. Lastly the European bio-economy strategy calls for global solutions where global challenges arise. Therefore this bio-economy concept could become very important also for forest policy-making where wood mobilisation activities to boost among other things forest biomass production and generation of green energy are encouraged.

The general assumption that guides this paper is that discourses, resulting ideas and arguments are generally said to have performative power. They shape actors views, influence their behaviour, impact on beliefs and interests and they can cause institutional change in a given society. We understand discourses as “an ensemble of ideas, concepts, and categorizations that are produced, reproduced, and transformed in a particular set of practices and through which meaning is given to physical and social realities” (Hajer 1995, 44).

However, on the one hand, critics argue that bio-economy is just a new slogan for old ideas and therefore only old wine in new bottles. On the other hand the bio-economy has the potential to become an influential global meta-discourse. Meta-discourses are defined as related to global economics, politics and culture in general and that have affected forest-specific discourses. Basing on these assumptions the aim of this paper is twofold: first, it aims to analyse if the ideas used in the bio-economy discourse differs from those in other global meta-discourses of the last decades, such as the ecological modernization discourse or the sustainable development discourse. Secondly, this paper aims to analyse whether and how the bio-economy discourse has started (or not) to reshape or overshadow the 'classical' forest discourses, such as sustainable forest management, forest biodiversity or forest and climate change. Classical forest discourses are defined as those shaping the contents of international forest policies.

Theoretically the paper is anchored in discourse theory. Crucial for discourse theory is not whether such ideas, concepts and categorizations are true or false, but that they exist, shaped within certain social practices to make sense of the physical and social world. Crucial as well is that discourses are not to be considered ‘objective givens’, but ‘historical constructs’ of language-in-use, societal norms, various types of knowledge (scientific, professional, lay) as well as of power mechanisms in a society over larger time frames (Fischer 1993, 2003). Hence, discourses are neither ‘objective truths’ nor ‘false ideologies’, but exist at the interface of politics, science, values and knowledge. In addition, discourses generally exhibit, like institutions, a so-called long durée (Giddens 1984). They can be very stable and they do seldom change overnight. However, this does not exclude discursive change, e.g. through agency. Discursive change agents are those actors, groups or coalitions that are able to reframe a certain discourse (Benford and Snow 2000; Schmidt 2008). An example is the Brundtland

Commission, who reshaped the sustainability discourse in the 1980s. Hence influential actors may re-frame discourses, for example when their frames resonate in the media, in science and politics. So the relationship between discourses and actors is dialectical. Discourses shape the perspectives of actors, while the latter can in turn reshape the former. We also assume a similar dialectical relationship between discourses and regulatory instruments. Certain instrument choices (e.g. a protocol, a fund, a voluntary market, etc.) are not choices made in a discursive vacuum, but informed by the dominant ideas, concepts and categorizations on regulatory instruments of that specific time period.

The empirical part of the paper employs a longitudinal analysis of global forest(-related) discourses and their dynamics since the 1960s based on existing scientific literature, distinguishing international meta and forest discourses<sup>1</sup>. While describing the discourses, the role of actors in discursive dynamics will be shortly scrutinized for each discourse. As literature on bio-economy discourse has not been published in a way sufficient for scientific review, a discourse analysis of this part will be employed by using international political documents and media reporting of internationally acknowledged media, in addition to some scientific literature.

**Keywords:** bio economy discourse, discourse theory, global forest policy

## References

- Arts, B., Appelstrand, M., Kleinschmit, D., Pölzl, H., Visseren-Hamakers, I. et al. (2010). Discourses, actors and instruments in inter- national forest governance. In: J. Raynor, A. Buck, & P. Katila (Eds.), *Embracing complexity: Meeting the challenges of international forest governance*. IUFRO.
- Benford, R. D. and Snow, D.A. 2000. Framing Processes and Social Movements: An overview and assessment. *Annual Review of Sociology* 26: 611-639
- Fischer, F and J. Forester. 1993. *The Argumentative Turn in Policy Analysis and Planning*. Duke University Press
- Fischer, F. 2003. Beyond empiricism: policy analysis as deliberative practice. In Hajer, A.M., Wagenaar, H. (eds). *Deliberative Policy Analysis: Understanding Governance in. the Network Society*, Cambridge University Press, p. 209-227.
- Giddens, A. 1984. *The Constitution of Society: Outline of the Theory of Structuration*. Cambridge: Polity Press
- Hajer, A.M. 1995. *The Politics of Environmental Discourse - Ecological Modernization and the Policy Process*. Oxford
- Schmidt, V.A. 2008. Discursive Institutionalism: the explanatory power of ideas and discourse. *Annual Review of Political Science* 11: 303-326.

---

<sup>1</sup>The basis of this paper builds on an already existing review of forest(related) discourses of the authors (Arts et al., 2010).

# Adjusting policy instruments to bio-based forest sector: a Delphi survey to assess stakeholders' standpoints

*Teppo Hujala<sup>1</sup>, Pasi Rikkonen<sup>2</sup>, Asta Ervola<sup>1</sup> and Jussi Uusivuori<sup>1</sup>*

<sup>1</sup>Finnish Forest Research Institute, Vantaa Unit, P.O. Box 18, FI-01301 Vantaa, Finland; teppo.hujala(a)metla.fi, asta.ervola(a)metla.fi, jussi.uusivuori(a)metla.fi

<sup>2</sup>MTT Agrifood Research Finland, Economic Research, Lönnrotinkatu 5, FI-50100 Mikkeli, Finland; pasi.rikkonen(a)mtt.fi

## Challenge of acceptable and cost-effective policies

The transition towards bio-based economy is a comprehensive endeavour, calling for coherent parallel activities from all actors and institutions throughout societies (see Geels 2005; Loorbach & Rothmans 2010). Public administration plays one of the key roles when designing and implementing policy measures that are expected to result in desired impacts: better resource efficiency and a shift towards carbon neutrality. In the forest sector, topical aims of transformation include, for example, adopting climate policies in national and sub-national levels; streamlining forest bioenergy value chains; novel use of wood for construction and furniture; and higher-value products from bio-refineries. The change process, catalysed by policy measures and activities of public bodies, can be seen as institutional adaptation in which operational behaviour is linked with organizational and social norms and motivations (Primmer 2011).

Laws, regulations, taxes, subsidies and soft informational tools not only need to be cost-effective but also generally acceptable by stakeholders and citizens (see Valkeapää & Karppinen 2013). This is particularly true when aiming at inducing the kind of socio-technological changes that bio-based economy necessitates (see Peltola 2011). When designing new policy instruments or renewing old ones, attention needs to be paid to the inner coherence of each instrument, i.e. the logic between the aim, functioning and impacts. Also coherence between policy instruments should be increasingly accounted for. Moreover, a proper analysis of stakeholders' viewpoints enables launching new instruments in the frame of deliberative, participatory governance (see Bäckstrand et al. 2010).

## Objectives

This study relates to the collaborative project “*Policy measures for sustainable use of natural resources*” (2012–2014), funded by the Finnish Ministry of Agriculture and Forestry. The project has served the Government in preparing the Forest Policy Report to the Parliament, which includes a proposal of a long-term (up to 2050) vision and strategic goals for using forests as well as a policy definition of the most central actions in Finland. Furthermore, the forthcoming results will inform the Finnish National Forest Strategy towards 2020.

This paper will i) conceptualize bio-based economy in terms of what it requires from new forest policy instruments; ii) describe a two-phase Delphi survey (cf. Rikkonen & Tapio 2010) to policy stakeholders, investigating the feasibility of policy instrument proposals; and iii) present the main results and implications of the first round of the survey.

## Interpreting bio-based economy from the perspective of new policy instruments

Forestry and forest-based industries can be regarded as parts of bio-based economy in the sense that they make use of renewable natural resources. Knowledge-based Bioeconomy report (Albrecht et al. 2010, p. 13) adds sustainability by defining bioeconomy as: “...the sustainable production and conversion of biomass, for a range of food, health, fibre and industrial products and energy.” Moreover, current understanding of the concept of bio-based economy links it closely to green economy, which suggests notably higher demands for the forest sector. According to UNEP (2011, p. 16), green economy is “...low-carbon, resource efficient, and socially inclusive.”

When looking at bio-based economy through the lens of the latter definition, a few important features for appropriate forest policy instruments can be outlined. Those include, for example, focus on sustainability in a wide sense; coherence with e.g. climate, energy, agricultural and environmental



policies; encouragement towards resource efficient production and consumption; ability to correct 'perverse incentives' that reinforce carbon economy; support to innovations; and acceptability among stakeholders. Furthermore, new policy instruments need to be operable to put in practice and cost-efficiently manageable. Above all, they need to foster systemic change towards green economy.

### **Essentials of the Delphi technique**

This study employs a web-based survey applying the Delphi technique, which is an anonymous, multi-level approach for interactive, deliberative analysis of future scenarios and desirable and feasible change (see Turoff 1970). The users of the Delphi technique aim to explore alternative future images, possibilities, their probabilities of occurrence, and their desirability by tapping the expertise of respondents. Linstone and Turoff (1975, p. 3) characterize Delphi as a method for structuring a group communication process in such a way that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem (see also Kuusi 1999; Rowe & Wright 2001; Tapio 2002; Rikkinen 2005).

The Delphi method consists of experts' judgement by means of successive iterations of a given questionnaire, to show convergence of opinions and to identify dissent or non-convergence. Anonymity and feedback can be considered as two irreducible elements of a Delphi technique. Traditionally, a third feature, consensus seeking, has been one additional element. However, nowadays consensus seeking is not a primary goal in Delphi applications (Tapio 2002). 'Disaggregative' policy Delphi processes may be used to identify issues in which experts' opinions show greatest variation, thus informing resource allocation to other phases of policy formulation processes.

### **Design of the Delphi survey**

In this study, the application of Delphi survey follows a sequence of phases: i) identifying policy instruments to be assessed; ii) enhancing the evaluation framework; iii) defining the expertise matrix; iv) selecting the sample of experts; v) conducting the two-stage Delphi survey; and vi) communicating the results to the stakeholders and policy-makers.

Stemming from the requirements above and recommendations by the project's steering group, five new policy instrument proposals, relating to the sustainable use of forests were generated: 1) educational vouchers to catalyse learning and networking of micro-sized enterprises in wood product branch; 2) carbon credits for family forest owners; 3) voluntary scheme of combined land area tax and timber sales income tax for forest owners; and 4) directing forestry subsidies from wood production investments to producing public goods. For each instrument, a brief narrative explanation was compiled to support consistent comprehension.

The applied policy evaluation framework draws on that by Mäki et al. (2011), and on the concepts and means of intervention chain analysis (Vedung 1997; Mickwitz 2003). Accordingly, questions included are: desirability of the objective; cost-efficiency and overall desirability of the tool; and expected sustainability impacts in economic, ecological and social dimensions.

To enable analysing different stakeholders' viewpoints for and against the new policy tool proposals and to make benefit from a strong account of wide expertise, a scheme of relevant expertise dimensions was composed. First, a general expertise of the operability, direct fiscal effects, and dynamic economic impacts of policy instrument types was recognized. Second, substance-based expertise was defined to contain knowledge and insight about the functionality, steering power, and various impacts and outcomes of the policy tools.

The sample of experts for the Delphi survey was picked from a large stakeholder bank containing a wide range of policy stakeholders. Using purposive sampling for heterogeneity (Silverman 2005, p. 129–130), sufficient coverage of all expertise dimensions was assured when picking the expert panel (N=577). The dimensions included the main expertise area (agriculture, forestry, environment), expertise perspective (economy, rural development, energy and climate, technology, societal and social policy, natural sciences), organizational background (research and education, private business, public

administration, NGO, extension and consultation, advocacy), and the status of professional career (early, middle, late, emeritus).

### First round results and implications

The first phase Delphi yielded total of 173 responses (response rate 30%) and revealed general opinion patterns concerning the desirability and feasibility of the policy instrument proposals. Figures 1-3 below show means and standard deviations of responses for three relevant questions: the overall desirability of the tool, the desirability of the policy objective behind the tool, and the cost-efficiency of the tool. The educational vouchers received the most favourable ratings. The combined forest tax system was the least desired, and the carbon credits for family forestry were considered the least cost-efficient.

The positive and neutral open response argumentation on educational vouchers emphasized the viewpoint that the effectiveness and desirability of the voucher system will depend on how it will be implemented. The critical viewpoint was that micro-sized enterprises have no time to participate trainings. The arguments on reforming the forest subsidy system were two-fold: while some respondents (mainly environmental experts) considered subsidizing public good provision a reasoned direction, other (mainly forestry practice experts) pointed out the risk of decreasing forestry activity and employment. The forestry tax system renewal received multiple opposing arguments, mainly criticizing the administrative infeasibilities and questioning the aim of increasing timber supply. The carbon credit system in family forestry was perceived too complicated and ineffective.

Based on these results, the carbon credits were decided to be dropped from the second Delphi round. Further information on how it could be feasible to continue with establishing educational vouchers will be gathered with special interviews to educational training and adult learning experts. The renewal of forestry subsidies was decided to be refined for the second round questionnaire, and a different tax system renewal was compiled to replace the first round proposal.

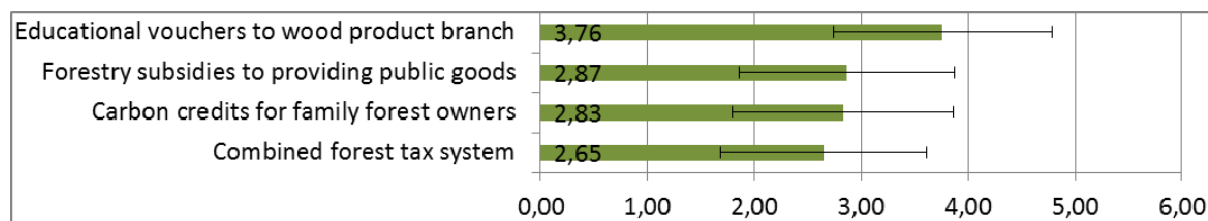


Figure 1. Means and standard deviations regarding the overall desirability of the proposed tools (n=126-134).

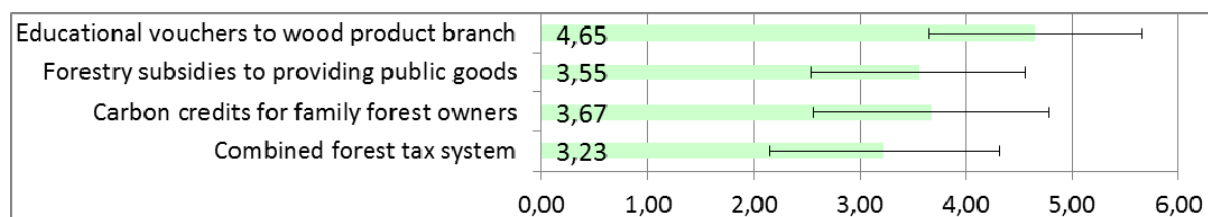


Figure 2. Means and standard deviations regarding the desirability of the policy objectives behind the tools (n=131-137).

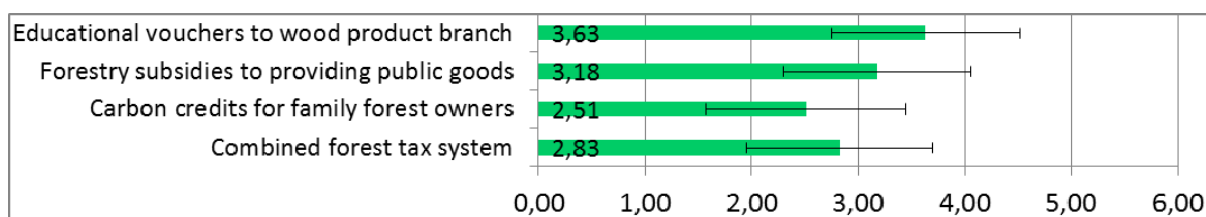


Figure 3. Means and standard deviations regarding the cost-efficiency of the proposed tools ( $n=131-136$ ).

Based on a part of the open response argumentation it was found out that the brevity of the narrative explanations of the instruments preceding the questions possibly prevented a full and consistent comprehension by all respondents. Taken the politically charged nature of the proposed instruments, the possibility of ulterior-motive response behaviour could not be ruled out either.

On the second round Delphi, the main supporting and opposing arguments towards each original policy tool proposal will be presented for respondents' assessment. After that, the main questions will be asked again to check consistency and enable learning based on the argumentation and the first round results. Then, the renewed policy tools will be described, and the same main questions as well as more detailed specific feasibility analysis questions will be asked.

For the basis of decision-making, a workshop dealing with the survey results as well as a "policy brief" type of report will be served for administration and other interest and stakeholder groups. This dissemination of results will give justified recommendations on how to proceed and what to expect when preparing and launching the policy instruments that received generally the highest feasibility and effectiveness scores. It will also raise awareness of the required socio-technological change towards greener bio-based economy.

**Keywords:** expertise, feasibility, green economy, participatory governance

## References

- Albrecht, J., Carrez, D., Cunningham, P., Daroda, L., Mancina, R., Máthé, L., Raschka, A., Carus, M. & Piotrowski, S. 2010. The Knowledge Based Bio-Economy (KBBE) in Europe: Achievements and Challenges. Clever Consult BVBA (Belgium).
- Bäckstrand, K., Khan, J., Kronsell, A. & Lövbrand, E. 2010. Environmental Politics and Deliberative Democracy – Examining the Promise of New Modes of Governance. Edward Elgar, Cheltenham.
- Geels, F.W. 2005. Technological Transitions and System Innovations: A Co-evolutionary and Socio-Technical Analysis. Edward Elgar, Cheltenham.
- Kuusi, O. 1999. Expertise in the future use of generic technologies. Epistemic and methodological considerations concerning Delphi studies. *Acta Universitatis oeconomicae Helsingiensis*, A-159. 268 p.
- Linstone, H.A. & Turoff, M. 1975. The Delphi Method: Techniques and Applications. Available on the Internet: <http://is.njit.edu/pubs/delphibook/>.
- Loorbach, D. & Rotmans, J. 2010. The practice of transition management: Examples and lessons from four distinct cases. *Futures* 42: 237–246.
- Mickwitz, P. 2003. A Framework for Evaluating Environmental Policy Instruments: Context and Key Concepts. *Evaluation* 2003(9): 415–436.
- Mäki, O., Ovaskainen, V., Hänninen, H. & Karppinen, H. 2011. Metsäpolitiikan ohjauskeinot: Arviointikehikko ja sovellus Suomen metsäpolitiikkaan [Forest policy instruments: evaluation framework and its application to the Finnish forest policy]. Working Papers of the Finnish Forest Research Institute 213. (in Finnish)
- Peltola, T. 2011. Energy Policy or Forest Policy or Rural Policy? Transition from Fossil to Bioenergy in Finnish Local Heating Systems. In: Järvelä, M. & Juhola, S. (eds.). *Energy, Policy, and the Environment: Modelling Sustainable Development for the North*. Studies in Human Ecology and Adaptation 6: 155–171.
- Primmer, E. 2011. Analysis of institutional adaptation: integration of biodiversity conservation into forestry. *Journal of Cleaner Production* 19(16): 1822–1832.
- Rikkinen, P. 2005. Utilisation of alternative scenario approaches in defining the policy agenda for future agriculture in Finland. MTT Agrifood Research Reports 73.

- Rikkinen, P. & Tapio, P. 2009. Future prospects of alternative agro-based bioenergy use in Finland – constructing scenarios with quantitative and qualitative Delphi data. *Technological Forecasting and Social Change* 76(7): 978–990.
- Rowe, G. & Wright, G. 2001. Expert opinions in forecasting: the role of the Delphi technique. In: Armstrong, J.S. (ed.). *A Handbook for researchers and practitioners*. Kluwer, London. p. 125–146.
- Silverman, D. 2005. *Doing qualitative research* (2<sup>nd</sup> ed.). Sage, London.
- Tapio, P. 2002. The limits to traffic volume growth. The content and procedure of administrative futures studies on Finnish transport CO<sub>2</sub> policy. *Acta Futura Fennica* 8. Available on the Internet: <http://ethesis.helsinki.fi/julkaisut/maa/limno/vk/tapio/>.
- Turoff, M. 1970. The design of a policy Delphi. *Technological Forecasting and Social Change* 2(2): 149–171.
- UNEP. 2011. *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*. United Nations Environment Programme. Available on the Internet: [www.unep.org/greeneconomy](http://www.unep.org/greeneconomy).
- Valkeapää, A. & Karppinen, H. 2013. Citizens' view of legitimacy in the context of Finnish forest policy. *Forest Policy and Economics* 28: 52–59.
- Vedung, E. 1997. *Public Policy and Program Evaluation*. Transaction Publishers, New Brunswick.

# Industrial forest plantations for pulp and energy in South America – opportunities and challenges

*Jan-Erik Nylund<sup>1</sup> and Juan Gowda<sup>2</sup>*

<sup>1</sup>Dept. of Forest Products, Swedish University of Agricultural Sciences, PO Box 7008, 750 07 UPPSALA, Sweden, jan-erik.nylund@slu.se,

<sup>2</sup>National Council of Scientific and Technical Research, Laboratorio Ecotono, Quintal 1250, 8400 Bariloche, Argentina, [juan.gowda@gmail.com](mailto:juan.gowda@gmail.com)

## ITP in South America

Any estimate of energy biomass demand for Europe alone shows that it cannot be covered regionally, even if the current reduction in printing paper demand continues (Economist, 2013). Emerging markets for paper and energy, particularly in the BRIC countries, are meanwhile growing at a high pace. The larger part of that expansion is catered for by industrial tree plantations (ITP) in South America, and to a lesser degree by South East Asia. In this report, we review the opportunities and challenges of a further expansion of ITP for pulp and energy biomass in Brazil, Chile and Uruguay. We don't consider other South American countries to become likely actors within the coming decade.

## Current situation

Brazil is one of the world's largest producers of short fiber pulp, having expanded from 4,4 mi t in 1990 to 14 mi t in 2012, or 7% of the world production (Sweden 12 mi t; Finland 10 mi t). Due to the very high productivity of its eucalypt plantations, only 2,5 mi ha are used for pulpwood, while another 4 mi ha are used for energy for metallurgy. These figures should be compared with 25 mi ha for soya and 8,5 mi ha for sugar cane, mostly for alcohol. ITP are mostly company owned and concentrate around mill sites, near the coast or rail connections. The Brazilian forest industry caters for a large domestic market. However, the present expansion of the pulp and paper capacity is intended for export; the total export value in 2012 was 6, 7 billion USD.

Chile has 2,3 mi ha under plantations, (65% pine) taking up around 15% of the total land area in the regions where climate is suitable for ITP. With a small domestic market, Chile has directed most of its industrial production to export markets, developing a broad basis for its ITP. ITP related exports totaled 4.9 billion USD year 2010, of which pulp and paper contributed with USD 3 billion and solid products with USD 1.1 billion.

In contrast with Brazil and Chile, where ITP are established in areas historically covered by natural forest, Uruguay is mostly covered by natural grasslands, but with soil and climate suitable for ITP. The country made a policy decision in the 1980s, introducing legislation and land classification adapted to ITP. Today, ITP cover 1.26 million hectares, equivalent to almost 8% of the total land area of the country, with an estimated upper limit of 1,5 to 2 mi ha. A large fraction of the plantations are owned by the two mills; there is little local know-how or interest in large-scale plantation forestry (DIEA 2003). With one pulp mill in production (a second will be in operation in 2014), the export value of pulp was 800 million USD.

## Opportunities and challenges

Looking at total land availability, there are no set limits to expansion of ITP for energy and pulp in Brazil, while both Chile and Uruguay are approaching absolute limits. Yet, biomass production regardless of purpose is subject to market forces. Establishment of ITP has brought with it rapid rises in land value to a point where pulp companies are trying to outsource tree growing to land owners who can get a better rent from their land than present use, mostly extensive cattle production, can provide. Bracelapa (2013) compares export earnings (processed products) per hectare of land required for the raw material, where the pulp and paper sector leads shares a first ranking with coffee at 3 000 USD/ha, followed by sugarcane alcohol, 2 000 USD/ha and the soy complex, 1000 USD/ha. Growing maize for export is a miserable business, with 200 USD/ha. These figures don't take the required capital investments into account and differ of course from the rent a land owner can expect from selling wood

or soybeans. Considering that the same kind of infrastructure is required for pulp and pellet processing and export, it is to be expected that (export-oriented) pelleting facilities and plantations would be concentrated in the same areas, adding pressure upwards on land prices. For a person already owning land, the local market and the opportunity cost will decide if energy wood will be grown. For energy companies entering the area, one may ask if land acquisition for energy crops will be viable of this reason; rather, we expect such ventures to be based on contract growing. The existence of both pulp and energy wood buyers in the area would strengthen the bargaining position of such growers – up to a ceiling set by global market prices.

However, land use involves much more than economics. In all Latin America, the heritage of colonization entails a strong preference for “opening the land to civilization”, i.e. deforestation has been considered virtuous and an open landscape is preferred. Dense tree plantations are considered to be a negative factor in the landscape “Eucalypt cannot be eaten” is a favoured slogan, while nobody seems concerned about the existence of vast low-productive rangelands nearby. With the low population density, it should be possible to greatly expand intensively managed tree plantations for all kinds of purposes.

Yet, under the present business model, with company enclaves that little engage the surrounding region, local people have no incentive to engage actively in tree growing – and thereby develop more positive attitudes to forestry. In our opinion and contrary to the more radical NGO criticism, national and global, it would be fully possible to continue restoring the coastal rainforest, develop a small-scale family farming system, and grow trees both by companies and private growers in Brazilian regions with adequate climate and infrastructure. That, however, requires active measures such as making efficient already existing land reform policies, and installing agricultural extension and credit systems. The current policy climate rather favors continued company expansion serving the interests of a global market only, if profitable also into energy biomass production, at the expense of local communities and inviting a policy backlash as forestry is perceived as increasingly illegitimate.

A successful bio-based economy should mean much more than further intensifying land use at the expense of natural environment and local societies. We are seeing natural forest being replaced in South east Asia to make room for oil palms, enormous areas of *selva*, *pampa* and *cerrado* in Latin America being converted to soy and cane growing, not to talk about “ecological beef”; in Africa, vast tracts of forests are leased to harvest biomass for China, while local farmers are evicted and no policies exist for stimulating small scale agriculture. There is an overt risk that expanding energy biomass growing will be just another step in a “neo-colonialist” process (cf. Wiener Bravo 2011; Kröger & Nylund 2012).

## References

- BRACELPA, 2013. Dados do setor. <http://www.bracelpa.org.br/bra2/sites/default/files/estatisticas/booklet.pdf>. Accessed 22 April, 2013
- DIEA, 2003. La actividad forestal a través del censo agropecuario. Ministerio de ganadería, agricultura y pesca, Montevideo, Uruguay. [www.mgap.gub.uy/portal/agxppdwn.aspx](http://www.mgap.gub.uy/portal/agxppdwn.aspx)? Accessed 10 April 2013
- Economist, April 6, 2013. Bonfire of the subsidies and Wood, the fuel of the future.
- INFOR, 2011. El sector forestal chileno 2011. Valdivia, Chile. [http://web.ffm.cl/index.php?option=com\\_jdownloads&Itemid=5&view=finish&cid=152&catid=8](http://web.ffm.cl/index.php?option=com_jdownloads&Itemid=5&view=finish&cid=152&catid=8), accessed 18 April, 2013
- Kröger & Nylund 2012. The conflict over Veracel pulpwood plantations in Brazil – application of ethical analysis. *Forest Policy and Economics*, 1: 74-82
- Uruguay, 2013. Informe de comercio exterior de Uruguay Año 2012. Govt. Of Uruguay, <http://www.uruguayxxi.gub.uy/wp-content/uploads/2011/11/Informe-de-Comercio-Exterior-de-Uruguay-FINAL-A%C3%B1o-2012.pdf>
- Wiener Bravo, E. 2011. La concentración de la propiedad de la tierra en América Latina: una aproximación de la problemática actual. Coalición Internacional para el Acceso a la Tierra, Lima, Perú. ISBN 978-92-95093-52-2

# **Why meagre results despite good conditions and large activity? A case study on the renewal process of the Finnish forest sector 2005-13**

*Jakob Donner-Amnell*

Karelian Institute, University of Eastern Finland, P.O. Box 111, FI-80101, Joensuu, Finland. [jakob.donner-amnell@uef.fi](mailto:jakob.donner-amnell@uef.fi)

In recent years, forest use in Europe has been affected by many new, partly conflicting goals and developments. A restructuration of forest-industrial production has been taking place especially after 2008. This development, following a similar trend starting in North America after 2001, has resulted in decrease of forest-industrial production in some countries. Forest use for other purposes, such as bioenergy, biodiversity, recreation, and carbon sequestration, has increased in many countries, partly as a result of different policies formulated by EU and nation states.

So it is easy to find a lot of open questions concerning forest use in Europe. Will we see more or less forest use in the future? Will industrial forest use still dominate forest use or will other forms of forest use play a more important role? Which factors have the biggest influence on the development of these issues? How should policies be formulated to ensure a proper balance between different goals and interests?

In this context, Finland is an interesting case. A restructuration of forest industry started almost a decade ago. As this sector still is rather important, many measures have been put through to advance renewal of the industry and forest use. Despite this, a substantial decrease of forest-industrial production has taken place. In this paper, a thorough analysis of these developments is made, as this possibly can produce insight about the conditions for renewal of forest use and policy. The purpose is to evaluate different explanations of the present situation and the process leading to it.

In order to give a coherent picture of the setting, several closely related issues will be studied. The long-term structure and character of the global forest industry will be touched upon. The operating environment of the forest industry has undergone substantial change since 1990s, which will be described. The main focus will be on how the Finnish forest industry, the Finnish state and other actors have interpreted the occurring challenges, what goals have been formulated and what measures have been implemented. A key question will be why the capacity for renewal of the Finnish forest sector has not been as good as expected and which factors might better it in the future.

Capacity for renewal is a concept and an analytical frame developed by the German political scientist Martin Jänicke. It is try to evaluate the ability of countries, industrial and administrative sectors or companies to identify and solve economic, social and ecological questions in an orderly and sustainable way, also by using new solutions and changing structures. The concept has been further divided into strategic, innovative and consensual capacity, which also can be studied separately. (Jänicke 1990)

Renewal of an actor struck by a crisis is an open-ended process influenced by many factors. The need to overcome the crisis and the will to formulate and strive towards new goals can be key drivers, produced by new economic or political circumstances. But typically renewal is also advanced by pressure originating from different sources: other countries, competing companies or sectors, consumers, media, civil society, or regulation. Also the extent to which new goals, solutions and interests are integrated in the renewal process can play a key role.

Capacity for renewal is strongly affected by the history, mentality and economic base of the actor in case. Countries have different economic bases and strong sectors, and this in turn is reflected in strategic choices, economic policies and problem-solving traditions. Typically, it is possible to recognize rather stable patterns in how national business models function and clear variety between countries.

When looking at Finland from these perspectives, it can be stated that Finland's business model since long has been strongly built around the forest industry and a small number of key companies close to this field (including energy, metal, engineering and chemical industry). The country belongs to the most forested in

Europe and has a long history of large, relatively well-balanced and controlled forest use and management. Forest-industrial production grew big and very important for the national economy already in the 19<sup>th</sup> century. This meant that many measures to support the development of forest industry gradually were taken in use in many policy areas.

Growth and modernization of the economy was the top priority especially after WW2, with somewhat less concern for social and ecological considerations. Still, the Finnish business model functioned pretty well until early 1990s without experiencing big structural problems or receiving strong criticism from inside. The model was accepted, because it produced a sufficient rate of growth, employment, revenue and renewal.

But as a result of many coinciding factors, Finland and the forest sector experienced a severe crisis in early 1990s and the national business model was questioned on many grounds. The forest sector had to face a lot of pressure from different sources: paper markets, consumers, ENGOS, citizens, and authorities. Because of this, a process of ecological modernization took place in the forest sector took during 1990s. The Finnish business model was also in some other respects reformulated to suit new challenges, such as globalization, membership in EU and EMU, and fast growth in new business segments, such as electronics.

The Finnish state still kept its strategic role as a back-up for the key export sectors and companies. As the Finnish economy and the forest sector soon recovered, the crisis in the 1990s did not lead to radical changes, but as much to a strengthened belief in the model and the key sectors (forest, metal and electronics). This was supported by the fact that Finnish companies soon after 2000 were global market leaders in mobile phones (Nokia), printing paper (Stora Enso and UPM), forest industry machinery (Metso) and forest sector consultancy (Pöyry). The Finnish forest companies scaled up their international and domestic production, so the forest industry represented about one fourth of Finnish exports still in early 2000s.

When the forest industry in many Western countries started to face growing challenges after 2000, the general attitude of the Finnish actors was still rather confident. The most frequently expressed view has been that the Finnish forest industry and related activities have “everything it takes” to meet the challenges and take advantage of new opportunities.

Since the first strong signs of an emerging restructuring of forest-industrial production occurred in Finland 2005-6, large activity has been taking place. The overall purpose has been to strengthen the competitiveness of forest-based production and to enhance its renewal. The amount of public debate, detailed studies, goal setting, and decision-making in many policy areas to support the process has been huge. Especially after 2008, the promising prospects offered by a global development towards bio economy have been frequently used as one of the strongest motives for action.

The most important public measures and allocations have been made in policies concerning energy, climate, R&D, infrastructure and forest. The long term goal has been to double the value of the whole forest cluster until 2030. Half of that value should come from present products and the other half from new products, such as biofuels and bio chemicals. The official goal of national forest policy is to make the forest sector a responsible bio economy pioneer and to increase domestic forest use to 65-70 million cubic meters/yr. Finland's RES goal is 38%, with forest biomass in a key role.

However, factual development in the forest sector has deviated from the goals these years. Forest-industrial production has decreased one fourth after 2007. Most of it is permanent. Some new products are on the way to enter into commercial production, but their value share is still today only marginal. Contrary to many plans and expectations, no big bio refineries have been built. The first small biofuel production units will start up their production in 2014. The use of domestic industrial round wood has decreased to about 50 million cubic metres/yr (down from record levels of 60 million cubic metres 2007). The only clearly positive numeric trends can be seen in increased use of wooden chips (mainly from logging residues) in bio energy production (from 3 to 8 million cubic metres/yr since 2007) and in the growing share of renewables in energy production. As the forest industry still is more important



in Finland than in any other European country, the loss of its export value, production and employment has had notable effects on the economy.

The prospects for the next 5-10 years are not promising either. This view can be supported by a number of factors. The profitability of the Finnish forest industry has not been restored to satisfying levels despite many closures and measures by companies and the state. The situation of the still very important printing paper segment is poor. The forest companies have not been able to put clearly more resources on developing new products. To turn bio economy prospects into profitable and large production would require a lot of “patient” capital, which the forest industry has not been able to attract.

Arguably, the single most worrying fact is that clear strategic moves away from troubled activities to more stable or promising ones have taken place neither in strategies of forest companies nor in different policies implemented by the state. Therefore, it is difficult to find any strong evidence showing that forest industry and forest-based activity in Finland would be in a clearly better position now in relation to the challenges and opportunities at hand. This would imply that decrease of production, employment and forest use will progress more strongly than renewal also during next 5-10 years, if no intervening factors affect present trends.

When analyzing the development of the Finnish forest sector, the explanatory strength of many different factors has of course to be considered. Renewal of a capital-intensive industry such as the forest industry is typically a slow process. The global recession has worsened the situation of the forest industry globally. The structural change of media and advertisement (a rapid move from printed to electronic channels) has affected paper production strongly. But global demand for many other forest-related products, such as pulp, packaging board, hygiene products, sawn timber, biofuels, recreation and tourism has continued to grow, so the overall situation for forest-based activities is far from bleak. When analyzing the interpretations and measures made by the Finnish forest sector actors and the state, it can be stated that the capacity to identify and react upon many key challenges has been far from sufficient. Accordingly, the strategies formulated and the measures implemented have been clearly more focused on securing the conditions of present strong actors than on advancing and integrating new goals, actors and interests. This is especially clear in policies concerning forest, energy and R&D, where the space and resources allocated for new actors still are very restricted.

In the Finnish case, it is possible to talk about a “crisis paradox”. The present structures of the forest sector have got bigger resources during the crisis – but no notable incentive or pressure to change. Therefore, strategies and policies officially focusing on enhancing change have reproduced status quo. The capacity for renewal has been weak also because the big forest companies have not been able or willing to contribute to it.

However, renewal of forest-based activities and forest-related policies might progress more strongly in the future. This might happen, if other economic sectors show better ability to grow and grab new opportunities, present strong forest sector actors and interests further weaken, other sectors show good ability to develop new bio-based products and activities, pressure induced by market or society causes a reformulation of forest policy goals, other forest-related interests and actors grow more in importance, value, social esteem or if other forest-related interests, actors and disciplines get a stronger voice in policy formulation.

**Keywords:** Forest use, forest industry, policy, bio economy, capacity for renewal

## References

Jänicke, M. 1990. Conditions for Environmental Policy Success: An International Comparison. *The Environmentalist*, 12: 47-58.

# Smart Green Growth for Mankind - The Contribution of Forestry to Bioeconomy

*Markku Ollikainen*

Department of Economics and Management, University of Helsinki, Finland. E-mail: [markku.ollikainen@helsinki.fi](mailto:markku.ollikainen@helsinki.fi)

Mankind faces most likely the biggest change since the dawn of the human race. Mitigating climate change requires a structural shift to carbon neutral economies and reduced use of natural resources in the face of strongly increasing population. The task is to decouple economic growth from resource use and environmental impacts, especially from fossil fuels. The key means are to get rid of carbon by pricing it efficiently and developing high-tech based intelligent solutions for production. Here the ideas of bioeconomy enter the concept of green growth. Besides carbon price, bioeconomy is one of the key elements for smart green growth. Bioeconomy is a multifaceted term but it refers to the innovative use of biomass from forest, agriculture, and the sea for both production and consumption. Bioeconomy may foster economic growth and create jobs in rural, coastal and industrial areas. This presentation discusses at length the potential contribution of forests to smart green growth taking as the background the fact the traditional forest industry – especially the demand for many paper products – is subject to large change globally. The number of potential products from woods is huge and current knowledge provides guidance for sustainable management of forest resources. The composition and intensity of demand for timber will change along with innovations and it may possibly create new requirements for forest management. The short term challenges include clarifying the role of climate and bioenergy policies in forestry, improving relevant institutions and logistics of production chains and fostering forest-based research and development.

**Keywords:** economic growth, innovation, forest biomass, climate and bioenergy policies

# Studying the Future of the Forest-Based Sector: Structural Changes towards Bioeconomy

*Hurmekoski, Elias<sup>1</sup>, Hetemäki, Lauri<sup>2</sup>*

<sup>1</sup>European Forest Institute, Torikatu 34, 80100 Joensuu, [elias.hurmekoski@efi.int](mailto:elias.hurmekoski@efi.int)

<sup>2</sup>European Forest Institute, Torikatu 34, 80100 Joensuu, [lauri.hetemaki@efi.int](mailto:lauri.hetemaki@efi.int)  
& University of Eastern Finland, Joensuu, Finland

This abstract is modified and significantly shortened version of Hurmekoski & Hetemäki (2013).

## Introduction

The concept of bioeconomy has gained popularity in the last decade. However, the interpretation of the concept may vary somewhat between different organizations. OECD (2009) highlights biotechnology and its contribution to economic welfare and competitiveness. On the other hand, the European Commission definition stresses grand socio-economic challenges, such as preventing the depletion of natural resources, reducing dependency on non-renewable resources, and mitigating climate change (EC 2012). The EC states that Europe needs to radically change its approach to production, consumption, and processing biological resources, in order to meet the increased demands of the growing global population and to maintain and improve Europe's economic competitiveness. The US Government also incorporates both these objectives to its agenda.

The forest-based sector is seen to be an integral part of bioeconomy. The concepts of the “forest-based sector” and the “forest-based bioeconomy” have already started to replace the conventional concept of the “forest sector”, reflecting the more diversified role of forests in satisfying the needs of the future society. Also, the forest industries in the mature Western markets are seeking to renew their businesses with novel forest-based products. High hopes are placed on the expectations related e.g. to the advancements in nanofiber, woodfiber composite, and biochemistry technologies and the new products that can be based on these (Clark et al. 2012, Hetemäki 2010). In addition, the renewable energy and climate policies are increasing the opportunities for forest biomass based bioenergy production. Also, following the megatrend of the 21<sup>st</sup> century, it is likely that there will be increasing demand for services related to forest-based products (e.g. Ali-Yrkkö et al. 2011, Baldwin 2012, Näyhä et al. 2014), forestry, and forests, but little research has been done on how this will affect the forest-based sector. Due to the above developments, the global forest sector is becoming more complex, cross-sectoral, and interlinked. As a result, major institutional and market-driven structural changes are likely to occur during the coming decades. With these changes, there is an increasing need to anticipate the possible future developments, and their implications. However, this task seems to grow ever more challenging due to the structural changes and complexities that induce such needs. Indeed, it appears that traditional forest sector outlook studies, such as those carried out by FAO (e.g., UNECE/FAO 2011), may not be able to fully capture these changes, and that complementary approaches would be needed in attempting to capture them.

The purpose of this study is to present the case for updating and complementing the traditional forest sector outlook approaches with methods from an increasingly cited field of research, i.e. foresight. By doing this, we argue, the studies can better contribute to anticipating probable and alternative future developments, and provide strategic information to support the transition of the forest based sector to the bioeconomy.

## The mainstream of forest sector outlook studies

The European Forest Sector Outlook Study (EFSOS II, see UNECE/FAO 2011) is the latest study in the well-known UNECE/FAO outlook series. It is different from the previous FAO outlook studies in that it also analyzed policy trade-offs by producing alternative scenarios with emphasis on different policies and forest uses. This kind of policy analysis and extensive outlook study that integrates different models and use also qualitative expert analysis can be seen to represent the state-of-the-art of the forest sector outlook approaches. However, typically long-term forest sector outlook studies have

focused on producing and evaluating long-term trends and projections for the sector, yielding conclusions on trade relationships between continents, and the future volume of demand for the main forest product groups. This restricts the topics of discussion to only the most conventional future developments, and gives less emphasis on the critical uncertainties related to long-term projections and new emerging products and services. The EFSOS II study is no exception in this sense, even though it depicts the consequences of different policy emphases.

In the forest economics and policy literature, the reviews on outlook studies have been scarce, and they mainly have focused on methods (econometric and numerical simulation models), and not on the relevance and ability to inform of the long-term development (e.g. Buongiorno 1996, Solberg & Moiseyev 1997, Toppinen & Kuuluvainen 2010). Focusing only on certain methods may be a serious shortcoming, as the commonly applied approaches tend to largely overlook structural changes and new products and services for which no data is available. For example, the forest sector models and outlook studies did not, and could not, in the 1990s anticipate the structural changes in paper markets, the EU 20-20-20 policies, or the impacts of forest based bioenergy to the forest sector. Today, these are all fundamental developments having large impacts on the present-day European and global forest sectors. The model-based forest sector outlook studies have for decades applied an econometric equation where the demand for a product is a function of the GDP, price, and lagged demand (see e.g. Kangas & Baudin 2003, Buongiorno et al. 2012). However, most of the prospective demand shifters discussed in the introduction are only partially or indirectly related to the GDP development (Hetemäki 2005, Hetemäki et al. 2013). Even if the models would consider structural changes by allowing the elasticities and other parameter assumptions to vary, the models themselves still operate tied to existing structures. For these reasons, projections subject to short-term demand shifters depicting the overall level of economic activity, such as GDP forecasts, are ever less likely alone to meet the need for diverse information for decision-making in the increasingly complex operating environment.

With the long-term prospects of the operational environment of the forest sector largely differing from what it has been for the past decades, there is a need for developing outlook approaches that are capable of assessing the prospective structural changes better than previously. In the following, we shortly review foresight approaches that might be able to contribute to these research problems in a more diverse manner.

### **Foresight tools for studying the structural changes of the forest-based sector**

Foresight thinking has been present in the forest sector in many high-level decision-making processes, for example in vision building and goal setting, strategy formulation, technology platforms, and policy-making (e.g. bioeconomy rhetoric, the foresight work of private enterprises, Forest-Based Technology Platform, and Forest Europe and EU Forestry Strategy processes). However, in forest economics journals, references to the established academic and methodological foresight literature have remained scarce.

There is a fundamental dilemma related to all future-oriented research: how can the future be studied, if it does not exist? According to Bell (2003), one of the authorities in the field, foresight incorporates discovering, evaluating, and proposing possible, probable and preferable futures. As no method can yield reliable information of the future in the strict sense, the value of foresight, and indeed any future assessment, has to be assessed through their usefulness in facilitating decision-making, i.e. through their ability to provide tools for strategic thinking.

Although it is somewhat open if foresight can be regarded as a science (Niiniluoto 2001), it specifically aims at scientific approaches, referring to the systematic and unbiased approach to handling data and interpreting results. It is critical to note that due to the ultimate aim of having an influence on the future, foresight also entails an explicit normative approach, which is not usually a part of scientific research. This does not mean that researchers would have the authority or obligation to define normative goals, but rather that they can study the normative goals set by decision makers or stakeholders. Policy-makers have been elected to define the goals for the society and stakeholders set their goals for the future based on their own interests. Given these normative objectives, it is then possible for the researchers to assess how these developments could be achieved, or analyze their

consequences on the markets. The procedure could be similar to performing ‘what if’-type of policy analysis on certain policy goals with traditional forest sector models.

In the foresight literature, there has been discussion on the validity and selection of methods for long-term future-oriented research (e.g. Voros 2003, Keenan & Popper 2007, Popper et al. 2007, Popper 2008a, 2008b, Glenn 2009, Roney 2010, Smith & Saritas 2011, For-learn 2013). In general, methods emphasising data and evidence, creative thinking, expert analysis, and stakeholder participation would be best combined to form a comprehensive analysis framework (see e.g. Popper 2008b).

A number of foresight methods allow tracking changes in the operating environment systematically and thus producing diverse background information for strategic decision-making. For example, agent-based modelling (e.g. Ligtoet & Chappin 2012) allows exploring alternative futures while not being necessarily tied to past structures. Also, the International Futures model (Hughes & Hillebrand 2006) type of approach would allow exploring several changes in the operational environment simultaneously through a fully integrated, heavily data-based global modelling framework. On the normative side, a backwards scenario technique widely used in the energy sector, i.e. backcasting, aims to set goals for the future and to determine the required steps to achieve them (For-learn 2013). Together these or other foresight methods could help to bridge the gap between normative vision statements and exploratory outlook studies, possibly contributing for more informed decision-making in the face of structural changes and ambitious targets laid under the concept of bioeconomy.

Despite the long traditions of forest sector outlook studies and a mounting body of scientific literature in the field of foresight, there is no clear distinction between “forest sector outlook approaches” and “foresight approaches”. Very few specific methods are exclusive to foresight research (with the exceptions of e.g. Delphi survey and backcasting, see e.g. Glenn 2009). The term foresight could simply refer to discussing and paying special attention to the validity of methods for long-term future assessments, i.e. such approaches that are systematic and explicitly recognize and allow for the possibility of structural changes, and uncertainties and limitations of long-term projections.

Forest sector models have value among other things in abstracting the complex operational environment into few key economic relationships. However, their shortcoming is that they tend to hold too many factors fixed in making long-term future assessments, and therefore missing important information for the decision makers. Therefore, it might be beneficial to combine these two lines of research, instead of treating them as separate topics of interest. In practice, one could for example first formulate scenarios of possible future directions of the operational environment with methods ranging from agent-based modelling (see e.g. Kostadinov et al. 2013) to participative foresight panels (see e.g. UNEP 2012), and then assessing the consequences of these scenarios into forest products markets with the help of forest sector models (see e.g. Toppinen & Kuuluvainen 2010, Latta et al. 2013).

## **Conclusions**

Typically, in producing long-term future scenarios, the forest sector outlook studies have yielded either normative vision statements or model-based explorative projections (see e.g. FTP 2012 and UNECE/FAO 2011, respectively). The link between the two approaches has remained weak. Even the state-of-the-art policy trade-off scenarios of UNECE/FAO (2011) depict rather conventional development paths, ignoring the emerging complexities and structural changes of the forest-based sector. On the other hand, the studies focused mainly on providing visions have generally not considered what should be done or what should happen in order to achieve them (see e.g. CEI-Bois 2004, CEPI 2011, FTP 2012). From these studies, it is difficult to identify important actors and drivers for assessing and improving the contribution of the forest-based sector to the bioeconomy.

Major structural changes are emerging, owing to for example declining communication paper consumption in OECD countries, heightened climate and energy issues on the policy agendas, the renewal of the forest industry businesses (new bioeconomy), the changing competitive advantages in global economy, and the increasing role of services. Given this, it is not enough, and can be even detrimental to restrict studies to only produce projections based mainly on exogenous GDP forecasts.

Instead, there is a need for additional and wider assessments of the bioeconomy development, reflecting also the structures and qualities of economy, not just the growth rate.

Two clear conclusions follow. First, long-term outlook studies would need to account for the emerging and prospective structural changes to better contribute to strategic thinking and decision-making. Second, foresight approach and methods could be useful for systematically tracking potential changes, taking account of the emerging complexities of the forest-based sector, and challenging conventional ways of thinking. While it is important for decision-making to make business-as-usual assessments tied to current structures, informative long-term outlook analysis generally requires one to focus also on the possible deviations from those historical trends.

**Keywords:** bioeconomy, foresight, outlook, structural change

## References

- Ali-Yrkkö, J., Rouvinen, P., Seppälä, T., Ylä-Anttila, P. 2011. Who captures value in global supply chains? Case Nokia 95 Smartphone. *Journal of Industry, Competition and Trade* 11: 263-278.
- Baldwin, R. 2012. Trade and industrialisation after globalisation's 2nd unbundling: How building and joining a supply chain are different and why it matters. *CEPR Discussion Papers*, 8768.
- Bell, W. 2003. *Foundations of futures studies: History, purposes, and knowledge*. Transaction Publishers, Piscataway, New Jersey.
- Buongiorno, J. 1996. Forest sector modeling: A synthesis of econometrics, mathematical programming, and system dynamics methods. *International Journal of Forecasting* 12: 329-343.
- Buongiorno, J., Zhu, S., Raunihar, R., Prestemon, J.P. 2012. Outlook to 2060 for world forests and forest industries: A technical document supporting the Forest Service 2010 RPA assessment. U.S. Department of Agriculture Forest Service, Southern Research Station. Technical Report SRS-151, Asheville, NC.
- CEI-Bois. 2004. Roadmap 2010. CEI-Bois, London.
- CEPI. 2011. The forest fibre industry - 2050 roadmap to a low-carbon bio-economy. Confederation of European Paper Industries. Brussels, Belgium.
- Clark, D., Aurenhammer, P., Bartlomé, O., Spear M. 2012. Innovative wood-based products, 2011–2012. In: UNECE/FAO. Forest products annual market review 2011–2012. Geneva Timber and Forest Study Paper 30.
- European Commission. 2012. *Innovating for sustainable growth: a bioeconomy for Europe*. Publications Office of the European Union, Directorate-General for Research and Innovation.
- For-learn. 2013. Support to mutual learning between foresight managers, practitioners, users and stakeholders of policy-making organisations in Europe. Available at: <http://forlearn.jrc.ec.europa.eu/index.htm>. [Accessed: 22/3/2013].
- FTP. 2012. Horizons - Vision 2030 for the European forest-based sector. Revised version. The European Forest-based Sector Technology Platform.
- Glenn, J.C. 2009. Introduction to the futures research methods series. In Glenn, J.C., Gordon, T.J. (eds.). *Futures Research Methodology: Version 3.0*. The Millennium Project, CD-r.
- Hetemäki, L., 2005. ICT and communication paper markets. *Information Technology and the Forest Sector*, IUFRO World Series 18: 76-104.
- Hetemäki, L. 2010. Forest biorefinery: an example of policy driven technology. In Mery, G., Katila, P., Galloway, G., Alfaro, R.I., Kanninen, M., Lobovikov, M. & Varjo, J. (eds.). *Forests and Society – Responding to Global Drivers of Change*. IUFRO World Series 25: 160-161.
- Hetemäki, L., Hänninen, R., Moiseyev, A. 2013. Markets and Market Forces for Pulp and Paper Products. In Hansen, E., Vlosky, R. & Panwar, R. (eds.). *Global Forest Products: Trends, Management, and Sustainability*, Taylor and Francis Publishers, USA.
- Hughes, B.B., Hillebrand, E.E. 2006. *Exploring and shaping international futures*. Paradigm Publishing Inc.
- Hurmekoski, E., Hetemäki, L., 2013. Studying the future of the forest sector: Review and implications for long-term outlook studies. *Forest Policy and Economics* 34, 17-29.
- Kangas, K., Baudin, A. 2003. Modelling and projections of forest products demand, supply and trade in Europe. A study prepared for the European Forest Sector Outlook Study (EFSOS). FAO, Geneva.
- Keenan, M., Popper, R. 2007. Practical guide for integrating foresight into research infrastructures policy formation. *ForeIntegra*.
- Kostadinov, F., Holm, S., Steubing, B., Thees, O., Lemm, R., 2013. Simulation of a Swiss wood fuel and roundwood market: An explorative study in agent-based modeling. *Forest Policy and Economics*, In press.
- Latta, G.S., Sjølie, H.K., Solberg, B., 2013. A review of recent developments and applications of partial equilibrium models of the forest sector. *Journal of Forest Economics*, In press.

- Ligtvoet, A., Chappin, E.J.L. 2012. Experience-based exploration of complex energy systems. *Journal of Futures Studies* 17: 57-70.
- National Bioeconomy Blueprint. 2012. The White House, Washington DC.
- Niiniluoto, I., 2001. Futures studies: science or art? *Futures* 33 (5), 371-377.
- Näyhä, A. Pelli, P. & Hetemäki, L. 2014. Services in the forest-based sector – unexplored futures. Submitted to *Foresight*.
- OECD. 2009. The bioeconomy to 2030: Designing a policy agenda. Main findings and policy conclusions. OECD International Futures Project.
- Popper, R. 2008a. How are foresight methods selected? *Foresight* 10: 62-89.
- Popper, R. 2008b. Foresight methodology. In Georghiou, L., Cassingena Harper, J., Keenan, M., Miles, I., Popper, R. (eds.). *The handbook of technology foresight: Concepts and practice*. Edward Elgar Pub, Northampton, USA, pp. 44-90.
- Popper, R., Keenan, M., Miles, I., Butter, M., Saintz, G. 2007. Global foresight outlook. Mapping foresight in Europe and the rest of the world. European Commission, European Foresight Monitoring Network.
- Roney, C.W. 2010. Intersections of strategic planning and futures studies: Methodological complementarities. *Journal of Future Studies* 15: 71-100.
- Smith, J.E., Saritas, O. 2011. Science and technology foresight baker's dozen: A pocket primer of comparative and combined foresight methods. *Foresight* 13: 79-96.
- Solberg, B., Moiseyev, A. (eds.). 1997. Demand and supply analyses of roundwood and forest products markets in Europe - overview of present studies. European Forest Institute, Joensuu. Proceedings 17.
- Toppinen, A., Kuuluvainen, J. 2010. Forest sector modelling in Europe - the state of the art and future research directions. *Forest Policy and Economics*: 2-8.
- UNECE/FAO. 2011. The European forest sector outlook study II 2010-2030.
- UNEP, 2012. 21 Issues for the 21st Century. Results of the UNEP Foresight Process on Emerging Environmental Issues. United Nations Environment Programme (UNEP).
- Voros, J. 2003. A generic foresight process framework. *Foresight* 5: 10-21.

# Investing in energy forestry under uncertainty

*Luca Di Corato*<sup>1</sup>, *Ardjan Gazheli*<sup>2</sup>, *Carl-Johan Lagerkvist*<sup>3</sup>

<sup>1</sup>Dept of Economics, Swedish University of Agricultural Sciences, Box 7013, SE-75007 Uppsala, Sweden. Email: [luca.di.corato@slu.se](mailto:luca.di.corato@slu.se)

<sup>2</sup>ICTA, Universitat Autònoma de Barcelona, Barcelona, Spain. Email: [a.gazheli@gmail.com](mailto:a.gazheli@gmail.com)

<sup>3</sup>Dept of Economics, Swedish University of Agricultural Sciences, Box 7013, SE-75007 Uppsala, Sweden. Email: [carl-johan.lagerkvist@slu.se](mailto:carl-johan.lagerkvist@slu.se)

In a few decades climate change may pose serious threats to society and urgent measures are required to face this challenge (World Wildlife Fund, 2011). In this respect, within the European Union, particular support has been given to renewable energy sources which, with respect to fossil fuels, may significantly contribute to lower greenhouse gas (hereafter, GHG) emissions.<sup>1</sup> Among renewables, biomass, mainly represented by forest wood, plays a prominent role in Scandinavian countries like Sweden and Finland (Eriksson et al., 2004).

In Sweden, bioenergy covers 18% of the energy supply (Aronsson et al., 2008). After the oil crisis of the 1970s, research was conducted in order to adopt short rotation coppice (hereafter, SRC) forests for the production of energy (Mola-Yudego and Gonzalez-Olabarria, 2010). As a result of this research effort, new varieties of SRC forests with higher yields and improved resistance against frost and fungal attacks were introduced. Of the various tree varieties, willow (*Salix*), due also to its ability to resprout after multiple harvests, has proved to be particularly rewarding in terms of yield (Buonocore, 2011).<sup>2</sup> Between 1991 and 1996 willow plantations increased significantly by 2,000 new hectares per year, reaching a total surface of about 16,000 ha. Three main factors contributed to this expansion. Firstly, the generous subsidies paid by the government,<sup>3</sup> secondly, the presence in Sweden of a well-developed system of district heat and power plants (hereafter, DHP) needing biomass as input<sup>4</sup> and thirdly, environmental taxes on sulphur and CO<sub>2</sub> emissions and energy taxes on fossil fuels which favoured tax exempt fuels such as biomass<sup>5</sup> (Rosenqvist et al., 2000; Johnsson et al. 2002). However, in 1996, after joining the European Union, the Swedish government decreased the subsidies granted to farmers investing in willow.<sup>6</sup> Lower subsidies, together with more volatile grain prices, had a negative impact on the establishment of new stands which reduced to only 500 new hectares per year. As a result, in the last 15 years the surface covered by willow has decreased reaching 12,500 ha in 2009 (Dimitrou et al., 2011; Rosenqvist et al., 2013).

Considering the importance that energy forestry may have in order to meet GHG reduction targets, it becomes crucial for the design of appropriate policies to understand what factors are driving the farmer's decision to afforest agricultural land. In this paper we view the farmer as holding an option to switch from traditional farming to energy forestry and frame the decision problem using option theory (see Dixit and Pindyck, 1994). Our approach allows us to properly account for specific features characterizing willow forestry, namely high sunk establishment costs, long-term commitment and highly uncertain net returns. We assume known and constant net revenues from forestry while we let agricultural net revenues follow a geometric Brownian motion. We determine the optimal timing for establishing new willow stands and then study the impact that government subsidies may have as a stimulus for this initiative.

Our paper belongs to the stream of contributions applying option theory in agricultural and forest economics. These applications include land set-aside (Isik and Yang, 2004), land-use change (Song et al., 2011; Musshoff, 2012), optimal harvesting problems (Clarke and Reed, 1989), old-growth forest conservation (Reed, 1993), and investment in afforestation (Thorsen, 1999).

The closest paper to ours is Musshoff (2012) where the author investigates conversion of set-aside land to short rotation coppice and suggests government measures to stimulate it. We depart from this contribution by developing a conceptual model where we also consider the impact of traditional agricultural return as investment opportunity cost. The model is then applied to assess the profitability of investing in SRC willow plantations in central-east Sweden. In this respect, we contribute by



providing a real option analysis of specific investment decisions which have, to the best of our knowledge, been investigated only under a standard net present value (hereafter, NPV) approach (see e.g. Rosenqvist and Ness, 2004; Ericsson et al., 2009).

Our results show that considering current subsidy level and net revenues from energy forestry and agriculture, the establishment of new willow stands is not attractive for farmers. However, the picture drastically changes if we account for the possibility of compensating farmers for the provision of services such as the treatment of the municipal sewage sludge. This is due to the fact that the above possibility entails two benefits for the farmer. First, the monetary compensation for the service provided and second the savings on the purchase of fertilizers which are excellently substituted by the sewage sludge obtained at no cost (Börjesson, 1999; Buonocore et al., 2011). These results suggest that there is room for improving the design of energy programs targeting the establishment of perennial energy crops. In fact, since plantations in the proximity of municipalities may be privately profitable even in the absence of subsidies, then potential savings could be used in order to provide additional support to farmers contemplating investment in energy forestry on lands where, due to their location, returns are limited to the biomass price paid by DHP plants and transport costs may further reduce the investment profitability.

**Keywords:** Real Options, Investment Analysis, Short-rotation Willow Coppice, Bioenergy Policy.

## Footnotes

**1** The European Parliament and Council introduced under Directive 2001/77/EC a system of feed-in tariffs, green certificates, tendering procedures and tax incentives to support the investments in renewable energies within the member states (EC, 2001).

**2** The establishment of a willow stand requires a long-term investment usually having a 20-25 year economic lifespan with harvests undertaken every 3-4 years (Mola-Yudego and Pelkonen, 2008, Lantmännen Agroenergi, 2008).

**3** Subsidies covered almost the entire establishment costs of the plantation (Rosenqvist et al., 2000). Every farmer willing to invest in a willow forestry project was in fact entitled to a SEK 10,000 subsidy and could also apply for grants covering fencing costs (Helby et al. 2006).

**4** In Sweden, willow plantations are usually located in the proximity of DHP plants (see Mola-Yudego and Gonzalez-Olabarria, 2010). Every winter 2500 ha of SRC willow are harvested to provide biomass to about 25 DHP plants in central and southern Sweden (Lantmännen Agroenergi, 2008). Sales are based on a bilateral agreement between the farmer and the local DHP plant. On the basis of such agreement, the DHP plant must buy the harvested willow at the current market price and the farmer is expected to sell the harvest to the plant. The presence of contractual agreements helps the farmer to reduce the uncertainties and risks associated with willow cultivation and secure the continuous and certain provision of a basic input factor for the production of energy (see Borjesson and Berndes, 2006).

**5** It is also worth highlighting that the introduction of green certificates in 2003 has significantly supported the demand for biofuels for energy production (Gohl, 2007).

**6** According to the prescriptions of the Swedish Board of Agriculture, farmers investing in the establishment of perennial energy crops are entitled to subsidies covering 40% of the establishment costs up to a maximum of SEK 5,000 per hectare (Jordbruksverks, 2011). These provisions are based on EU directives, EC 1698/2005 and EC 1974/2006, for the support of rural development. See also Regeringskansliet (2010).

## References

- Aronsson, P., Weih, M., Åhman, I., 2008. Bioenergy - for what and how much? *Formas Fokuserar*, 269-283
- Buonocore, E., Franzese, P.P., Ulgiati, S., 2011. Assessing the environmental performance and sustainability of bioenergy production in Sweden: a life cycle assessment perspective. *Energy*, 37 (1): 69-78
- Börjesson, P., Berndes, G., 2006. The prospects for willow plantations for wastewater treatment in Sweden. *Biomass and Bioenergy*, 30 (5): 428-438
- Börjesson, P., 1999. Environmental effects of energy crop cultivation in Sweden -- I: Identification and quantification. *Biomass and Bioenergy*, 16 (2): 137-154
- Clarke, H.R., Reed, W.J., 1989. The tree-cutting problem in a stochastic environment: the case of age-dependent growth. *Journal of Economic Dynamics and Control*, 13 (4): 569-595
- Dimitrou, I., Rosenqvist, H., Berndes, G., 2011. Slow expansion and low yields of willow short rotation coppice in Sweden; implications for future strategies. *Biomass and Bioenergy*, 35 (11): 4613-4618
- Dixit, A.K., Pindyck, R.S., 1994. *Investment under Uncertainty*. Princeton (NJ), Princeton University Press.
- EC, 2001. Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001. On the promotion of electricity produced from renewable energy sources in the internal electricity market. *Official Journal of the European Union*, vol. L 283: 33-40
- Ericsson, K., Huhunene, S., Nilsson, L.J., Svenningsson, P., 2004. Bioenergy policy and market development in Finland and Sweden. *Energy Policy*, 32 (15): 1707-1721
- Ericsson, K., Rosenqvist, H., Nilsson, L.J., 2009. Energy crop production costs in the EU. *Biomass and Bioenergy*, 33 (11): 1577-1586
- Göhl, L., 2007. An effective system to promote more bioenergy. The electrical certificate, *Bioenergy International*, 24 (1): 26-27. Available at <http://www.novator.se/bioint/BI24/26-27BioInt24.pdf>.
- Helby, P., Rosenqvist, H., Roos, A., 2006. Retreat from Salix-Swedish experience with energy crops in the 1990s. *Biomass and Bioenergy*, 30 (5): 422-427

- Isik, M., Yang, W., 2004. An analysis of the effects of uncertainty and irreversibility on farmer participation in the Conservation Reserve Program. *Journal of Agricultural and Resource Economics*, 29 (2): 242-259
- Johnsson, B., Börjesson, P., Ericsson, K., Nilsson, L.J., Svenningsson, P., 2002. The use of biomass for energy in Sweden - critical factors and lessons learned. Report No. 35. Lund.
- Jordbruksverket, 2011a. Föreskrifter om ändring i Statens jordbruksverks föreskrifter (SJVFS 2007:43) och allmänna råd om företagsstö d och projektstö d. SJVFS 2011:18. Available at <https://www.jordbruksverket.se/download/18.5586fdf512e8fc79a8480002844/2011-018.pdf>.
- Lantmännen Agroenergi, 2008. Manual for SRC Willow Growers. Available at [http://www.agroenergi.se/PageFiles/135/ENG\\_Odlarmanual%20Salix%20\(Revidering\).pdf?epslanguage=sv](http://www.agroenergi.se/PageFiles/135/ENG_Odlarmanual%20Salix%20(Revidering).pdf?epslanguage=sv).
- Mola-Yudego, B., Pelkonen, P., 2008. The effects of policy incentives in the adoption of willow short rotation coppice for bioenergy in Sweden. *Energy Policy*, 36 (8): 3062-3068
- Mola-Yudego, B., Gonzalez-Olabarria, J.R., 2010. Mapping the expansion and distribution of willow plantations for bioenergy in Sweden: lessons to be learned about the spread of energy crops. *Biomass and Bioenergy*, 34 (4): 442-448
- Musshoff, O., 2012. Growing short rotation coppice on agricultural land in Germany: A Real Options Approach. *Biomass and Bioenergy*, 41: 73-85
- Reed, W.J., 1993. The decision to conserve or harvest old-growth forest. *Ecological Economics*, 8 (1): 45-69
- Regeringskansliet, 2010. Landsbygdsprogram för Sverige 2007-2013. Available at <http://www.regeringen.se/content/1/c6/08/27/24/8186e1e7.pdf>.
- Rosenqvist, H., Roos, A., Ling, E., Hektor, B., 2000. Willow growers in Sweden. *Biomass and Bioenergy*, 18 (2): 137-145
- Rosenqvist, H., Ness, B., 2004. An economic analysis of leachate purification through willow-coppice vegetation filters. *Bioresource Technology*, 94 (3): 321-329
- Rosenqvist, H., Berndes, G., Börjesson, P., 2013. The prospects of cost reductions in willow production in Sweden. *Biomass and Bioenergy*, 48: 139-147
- Song, F., Zhao, J., Swinton, S.M., 2011. Switching to perennial energy crops under uncertainty and costly reversibility. *American Journal of Agricultural Economics*, 93 (3): 768-783
- Thorsen, J.B., 1999. Afforestation as a Real Option: Some Policy Implications. *Forest Science*, 45 (2): 171-178
- WWF (World Wildlife Fund), 2011. The Energy Report - 100% Renewable Energy by 2050. Gland, Switzerland.

---

The authors fully acknowledge that this abstract reuses material extracted from:

Forest Policy and Economics, Vol. 34, L. Di Corato, A. Gazheli, C. J. Lagerkvist, "Investing in energy forestry under uncertainty", Pages 56-64, Copyright © 2013, with permission from Elsevier; (ISSN 1389-9341, <http://dx.doi.org/10.1016/j.forpol.2013.06.001>)

---

Distribution  
Sveriges lantbruksuniversitet  
Institutionen för skogens produkter  
Department of Forest Products  
Box 7008  
SE-750 07 Uppsala, Sweden  
Tfn. +46 (0) 18 67 10 00  
Fax: +46 (0) 18 67 34 90  
E-mail: [sprod@slu.se](mailto:sprod@slu.se)